U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-257 601

PROGRESS IN THE IMPLEMENTATION OF MOTOR VEHICLE EMISSION STANDARDS THROUGH JUNE 1974, REPORT TO CONGRESS

ENVIRONMENTAL PROTECTION AGENCY

JUNE 30, 1974

268013

PB 257 601

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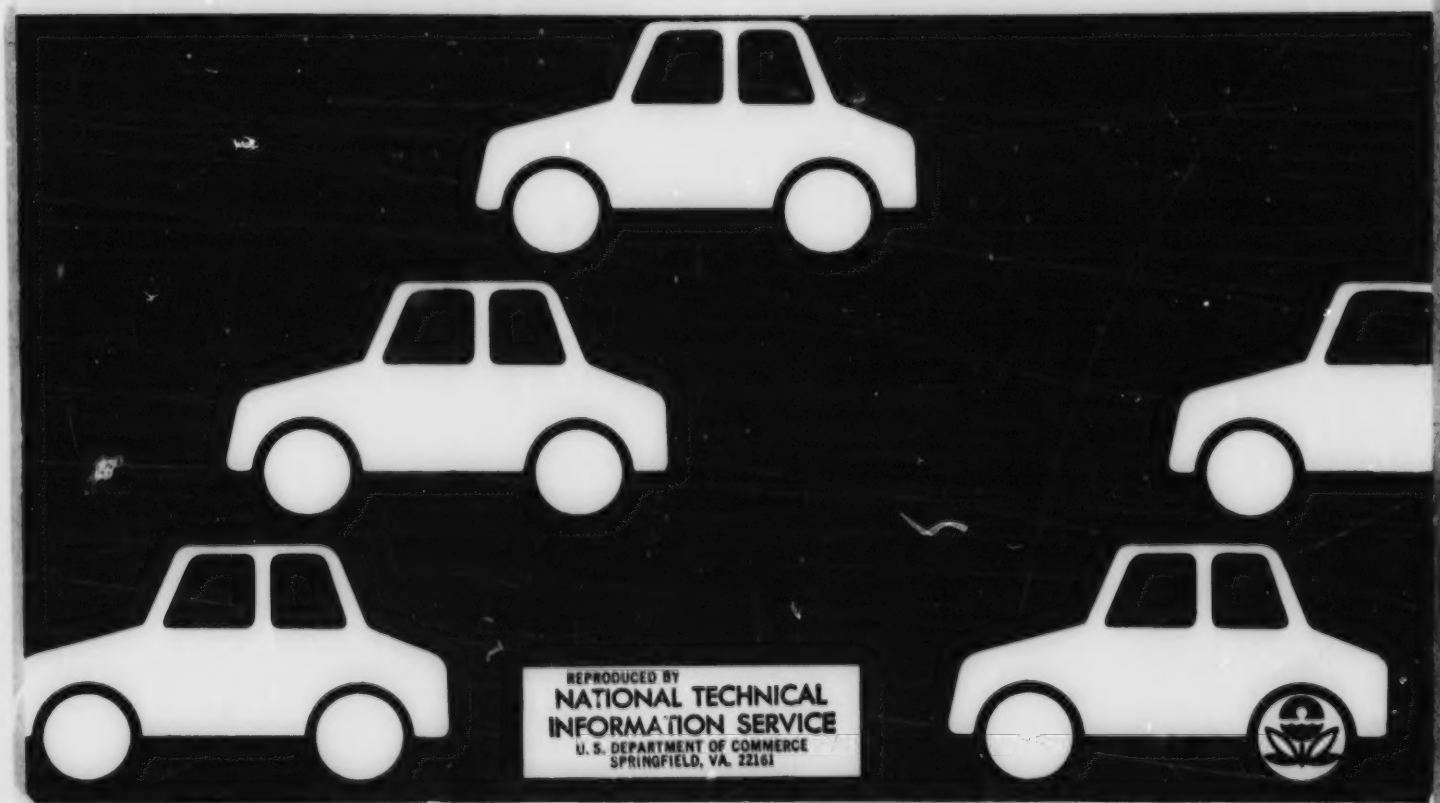
EPA 230/3-74-013



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STATES ENVIRONMENTAL
ON AGENCY

Report to Congress

4TH & M STREET SOUTH WEST
WASHINGTON, D.C. 20460

BIBLIOGRAPHIC DATA SHEET	1. Report No. EPA/230/3-74/013	2.	3. Recipient's Accession No. PB-257 601
4. Title and Subtitle Progress in the Implementation of Motor Vehicle Emission Standards Through June 1974, Report to Congress			5. Report Date 30 Jun 74 6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Environmental Protection Agency Washington, D.C.			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address			13. Type of Report & Period Covered 14.

15. Supplementary Notes
See also report dated Jun 75, PB-257 602.

16. Abstracts
The Clean Air Act, as amended in 1970, initiated a coordinated national effort toward reducing air pollution through research, regulations, enforcement, and related programs. The Act requires the Administrator to report yearly on measures taken in relation to motor vehicle emission control. This report covers the period July 1, 1973 through June 30, 1974.

17. Key Words and Document Analysis. 17a. Descriptors
*Air pollution abatement,
*Exhaust emissions,
*Motor vehicles,

Projects,
Performance evaluation,
Research,
REgulations,
Law enforcement,
Fuels,
Classifications,
Technology,
Benefit cost analysis,
Motor vehicle engines,
Catalytic converters.

17b. Identifiers/Open-Ended Terms

*Air pollution standards,
Clean Air Act.

17c. COSATI Field/Group 13 B

18. Availability Statement National Technical Information Service Springfield, Virginia 22161	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 161p
	20. Security Class (This Page) UNCLASSIFIED	22. Price 6.75/2.25

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

PREFACE

The Clean Air Act, as amended in 1970, initiated a coordinated national effort toward reducing air pollution through research, regulations, enforcement, and related programs.

Section 202(b)(4) of the Clean Air Act requires the Administrator to report yearly on measures taken in relation to motor vehicle emission control. Section 202(b)(4) reads as follows:

> "On July 1, 1971, and of each year thereafter, the Administrator shall report to the Congress with respect to the development of systems necessary to implement the emission standards established pursuant to this section. Such reports shall include information regarding the continuing effects of such air pollutants subject to standards under this section on the public health and welfare, the extent and progress of efforts being made to develop the necessary systems, the costs associated with development and application of such systems, and following such hearings as he may deem advisable, any recommendations for additional Congressional act on necessary to achieve the purposes of this Act. In gathering information for the purposes of this paragraph and in connection with any hearing, the provisions of Section 307(a) (relating to subpoenas) shall apply."

This report covers the period July 1, 1973 through June 30, 1974.

Table of Contents

Preface

I. Introduction and Summary I-1

II. EPA Actions II-1

A. 1976 NOx Emission Standard Decision II-1

B. Motor Vehicle Regulations II-4

1. Regulations for Light-Duty Diesel Passenger Vehicles II-4
2. Regulations for Light-Duty Gasoline Trucks II-4
3. Regulations for Light-Duty Diesel Trucks II-5
4. Motorcycle Regulations II-5
5. Non Methane Hydrocarbon Exhaust Emission Standards II-7
6. Regulations for Motor Vehicle Certification II-7
7. Regulations Defining Certificate of Conformity II-8
8. Regulations for Certification at High Altitudes II-9
9. Regulations for Certification of Low Emission Vehicles II-10
10. Regulations Defining Exclusions and Exemptions II-11
11. Recall Regulations II-11
12. Regulations for Importation of Catalyst-Equipped Vehicles II-12

C. Fuel Regulations II-13

1. Fuel Regulations for Lead-Free Gasoline II-13
2. Fuel Regulations for Low Lead Gasoline II-14
3. Regulations for Registration of Fuels and Fuel Additives II-14

III. Progress in Emission Reduction Technology III-1

A. Alternative Automotive Power Systems Program III-1

1. Conventional and Stratified Charge Engine III-1
2. Gas Turbine III-4
3. Rankine Cycle Engine III-8
4. Demonstration Vehicles III-9

B. Federal Clean Car Incentive Program III-10

C. Low-Emission Vehicle Purchase Program III-12

D. Feasibility of Alternative Fuels III-13

E. Assessment of Progress III-14

1. EPA Assessment III-14

2. National Academy of Sciences III-16

IV. Costs and Benefits of Meeting Emission Standards ..... IV- 1

A. Cost of Meeting Emission Standards ..... IV- 1

1. Light-Duty Vehicles ..... IV- 1
2. Heavy-Duty Vehicles ..... IV- 8
3. Lead-Free Fuel Regulations IV-12

B. Benefits of Meeting Emission Standards IV-12

1. Effect of Mobile Source Pollutants IV-12
2. Improvement of Air Quality IV-26

V. Related EPA Programs ..... V- 1

A. Certification Program for New Motor Vehicles ..... V- 1

1. Certification Determination ..... V- 1
2. Inspections and Investigations Program ..... V- 6
3. Exclusions and Exemptions Program ..... V- 6

B. Selective Enforcement Auditing Program for Production Vehicles ..... V- 8

C. Enforcement Activities for Vehicles In Use And Fuel Standards ..... V- 9

1. Antitampering Program ..... V- 9
2. Recall Program V-10
3. Warranties Program V-12
4. Aftermarket Parts V-12
5. Imports Program V-13
6. Fuels Program V-14

D. Other Emissions Inventory Programs V-15

1. Light-Duty Vehicle V-15
2. Heavy-Duty Vehicles V-15

E. Supporting Emissions Characterization Program V-16

1. Emissions at Nonstandard Temperatures V-16
2. Currently Unregulated Emissions V-17
3. Sulfate Emissions V-18

F. Transportation Control Plans..... V-19

1. Transportation Control Plan Measures..... V-20
2. Implementation and Cost..... V-27
3. Other Studies..... V-28

FOOTNOTES..... V-30

List of Tables

I.1 Existing Emissions Standards..... I-4

I.2 Emissions Standards for Heavy-Duty Gasoline and Diesel Engines..... I- 5

I.3 Major Regulations Proposed/Promulgated During 1973/1974... I- 6

IV.1 Emission Control Equipment Costs, 1974-1977 Model Year Light-Duty Vehicles..... IV- 2

IV.2 Emission Control Equipment Costs for 1978 Model Year Light-Duty Vehicles..... IV- 4

IV.3 Estimated Incremental Maintenance Costs for Emission Control Systems of Light-Duty Vehicles..... IV- 6

IV.4 Effect of Emission Controls on Fuel Economy of Light-Duty Vehicles..... IV- 7

IV.5 Estimated National Costs for Emission Controls for Light-Duty Vehicles..... IV- 9

IV.6 Estimated National Costs for Emission Controls for Heavy-Duty Gasoline Engines..... IV-11

IV.7 Adverse Health Consequences of Motor Vehicle Pollutants..... IV-15

IV.8 Possible Adverse Health Effects Which Might Logically Follow Exposure to Carbon Monoxide..... IV-17

IV.9 Adverse Health Effects Which Might Be Attributed to Photochemical Oxidant Exposures..... IV-18

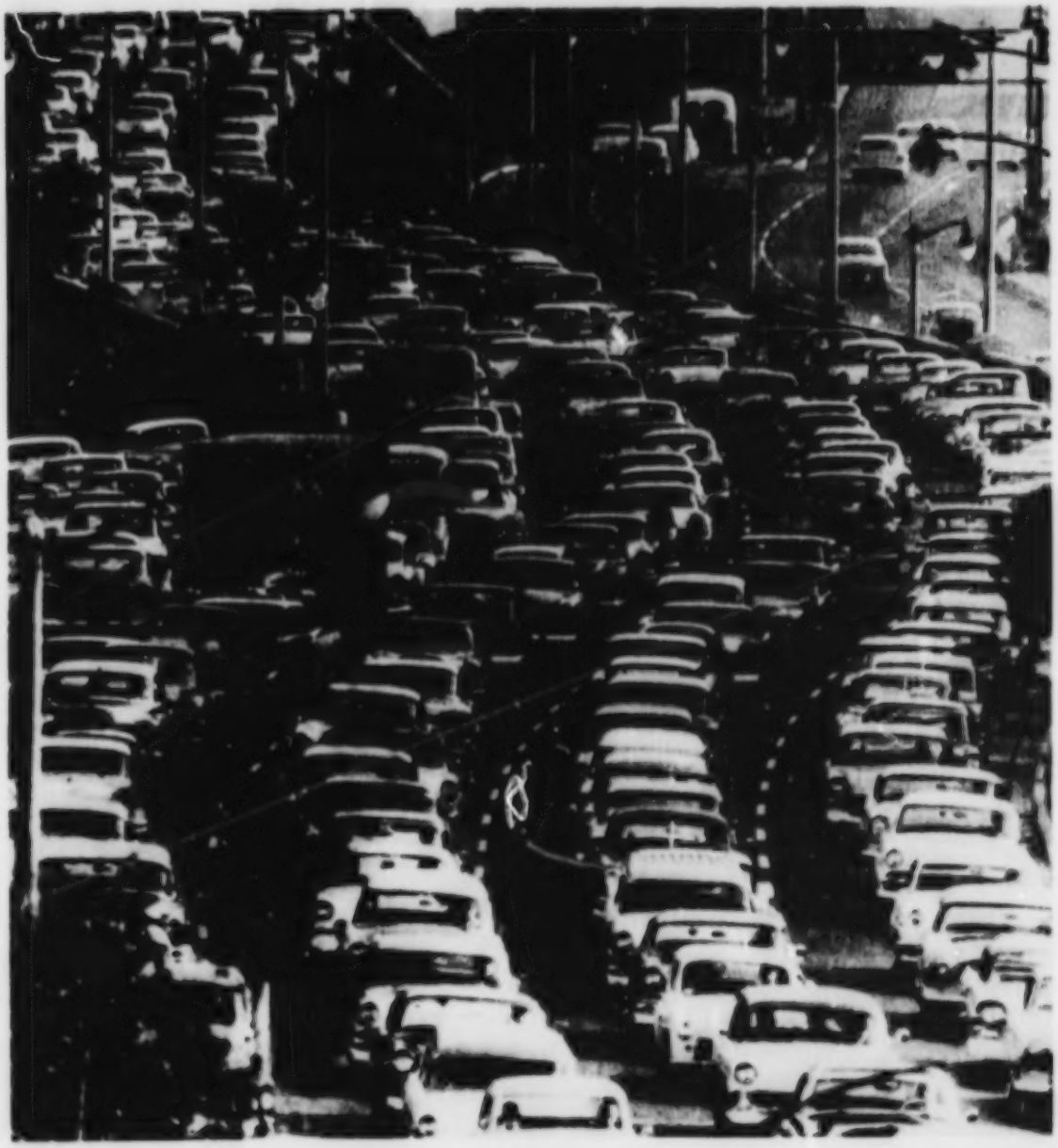
IV.10 Adverse Health Effects Which Might be Attributed to Nitrogen Dioxide..... IV-20

V.1 Gas Mileage for 1974 Automobiles..... V- 7

V.2 States with Transportation Control Plans..... V-21

List of Figures

III.	1.	Internal Combustion Engine.....	III-2
III.	2.	Stratified Charge Engine System.....	III-3
III.	3.	Gas Turbine Engine.....	III-5
V.	4.	Steps in Certification Process.....	V-2



EPA's effort in reducing mobile source emissions includes the setting of standards, the promulgation of regulations, program development, and research.

CHAPTER I. INTRODUCTION AND SUMMARY

The period for this report (July 1, 1973 - June 30, 1974) saw substantial development of EPA activities to control motor vehicle emissions.

The Clean Air Act allows the EPA Administrator to suspend for 1 year the statutory 1975 model year emission standards for hydrocarbons (HC) and carbon monoxide (CO) and the statutory 1976 model year emission standards for nitrogen oxides (NOx). In 1973, the EPA Administrator did suspend the statutory standards and set interim standards for HC, CO, and NOx. The suspension of statutory 1975 model year emissions standards was covered in the 1973 report to Congress. Suspension of the statutory 1976 model year emissions standards and setting of interim standards is discussed in Chapter II of this report.

In June 1974, the Energy Supply and Environmental Coordination Act changed the status of the interim standards and enacted new deadlines for emissions standards. According to the new Act, the Clean Air Act statutory standards for HC and CO (originally to be met by the 1975 model year) are now to be met by 1977 model year with the possibility of an additional one year extension. The Clean Air Act statutory standards for NOx (originally to be met by the 1976 model year)are now to be met by 1978 model year. Current standards reflecting the Energy Act provisions and EPA promulgations are summarized in Tables I.1 and I.2.

Currently, Legislative proposals revising standards are being considered. EPA in submitting legislative proposals to amend the CAA of 1970 on March 22, 1974, transmitted the Presidents proposals which would 1) extend the Federal auto emission standards applicable to the 1975 model

year for carbon monixide, hydrocarbons and nitrogen oxides through the 1976 and 1977 model years, 2) provide for review of regulations applicable to emissions of oxides of nitrogen from light duty vehicles and engines manufactured during or after the 1978 model year.

In addition to the suspension of emission standards, EPA proposed or promulgated standards setting emission levels in different vehicle categories and proposed regulations to ensure that motor vehicles meet emission standards (e.g., Regulations defining Certificate of Conformity, Recall Regulations, etc. see Table I.3).

The past year saw developments in a number of other areas as EPA:

- o developed fuel regulations requiring marketing of lead free fuels, established a schedule for phasing down lead content in fuels and proposed regulations for registration of fuels and fuel additives.
- o continued its Alternative Power Systems program which evaluates and develops alternative power systems to conventional internal combustion engines.
- o initiated contractor studies to assess the technical and economic feasibility of alternative fuels.
- o continued to support research by the National Academy of Sciences focusing on the technological feasibility and cost of meeting various NOx Standards.
- o continued research in assessing the costs and benefits of motor vehicle emission control.
- o continued its certification testing program, which tests prototype vehicles representing all new motor vehicles sold in the U.S. In the past year, completed certification of 1974 model year light-duty gasoline and diesel engines.
- o published fuel consumption results on 1974 model year vehicles in the Federal Register and as a booklet for consumer use.
- o expanded the surveillance and inspection of manufacturing facilities in order to ensure that certification procedures are observed. In the past year, conducted 24 in-depth inspections of domestic and foreign facilities.

- o developed a Selective Enforcement Auditing program in order to test new motor vehicles or new motor engines being manufactured in assembly line production.

- o undertook an investigation of 20 potential violations of tampering with emissions controls; referred five cases to the Justice Department. An EPA survey in Washington, D. C. found components of emission control systems had been removed in 15 percent of vehicles.

- o under the Recall Program, tested vehicles in use. EPA announced June 25, 1974 that four manufacturers of certain 1972 vehicles appeared to be in violation of Federal air pollution emission standards. One earlier investigation under this program led to a recall of 826,000 Chrysler vehicles. Thirty percent of the recalled vehicles have been remedied.

- o under the Imports Program, monitored approximately 3 million vehicles.

- o established a regional field sampling inspection system under the fuels program to assure availability of lead-free gasoline.

- o completed a report on emission testing of light-duty vehicles entitled "Automobile Exhaust Emission Surveillance--Analysis of FY 1972 Program."

TABLE I.1

EXISTING EMISSIONS STANDARDS

TYPE OF VEHICLE		1975			1976			1977[a]			1978		
		HC	CO	NOx	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
		(emissions expressed as grams per mile)											
Light duty gasoline passenger vehicle	(National)	1.5	15	3.1	1.5	15	3.1	0.41	3.4	2.0	0.41	3.4	0.4
	(California)	.9	9	2.0	.9	9	2.0						
Light duty diesel passenger vehicle	(National)	1.5	15	3.1	1.5	15	3.1	0.41	3.4	2.0	0.41	3.4	0.4
	(California)	.9	9	2.0	.9	9	2.0						
Light duty gasoline truck	(National)	2.0	20	3.1	2.0	20	3.1	2.0	20	3.1			
	(California)	2.0	20	2.0	.9	17	2.0						
Light duty diesel truck (proposed)	(National)				2.0	20	3.1	2.0	20	3.1			

[a] NOTE: The 1977 emission standards for hydrocarbons and carbon monoxide are listed in this table. The guidelines for determination of a 1 year suspension of HC and CO are found in House Report 93-1013 (pages 23-25). On March 22, 1974, EPA in submitting legislative proposals to amend the Clean Air Act of 1970, transmitted the President's proposals which would; 1) extend the Federal auto emission standards applicable to the 1975 model year for carbon monixide, hydrocarbons and nitrogen oxides through the 1976 and 1977 model years, 2) provide for review of regulations applicable to emissions of oxides of nitrogen from light duty vehicles and engines manufactured during or after the 1978 model year.

TABLE I. 2

EMISSIONS STANDARDS FOR
HEAVY-DUTY GASOLINE AND DIESEL ENGINES

Type of Engine		1975 and 1976 Model years (grams/brake horespower/hour) (a) HC and NOx (b)	CO
Heavy-duty Gasoline engine	(National)	16	40
	(California)	10	30
Heavy-duty Diesel engine	(National)	16	40
	(California)	10	30

a) Standards for 1977 and 1978 have not been set.

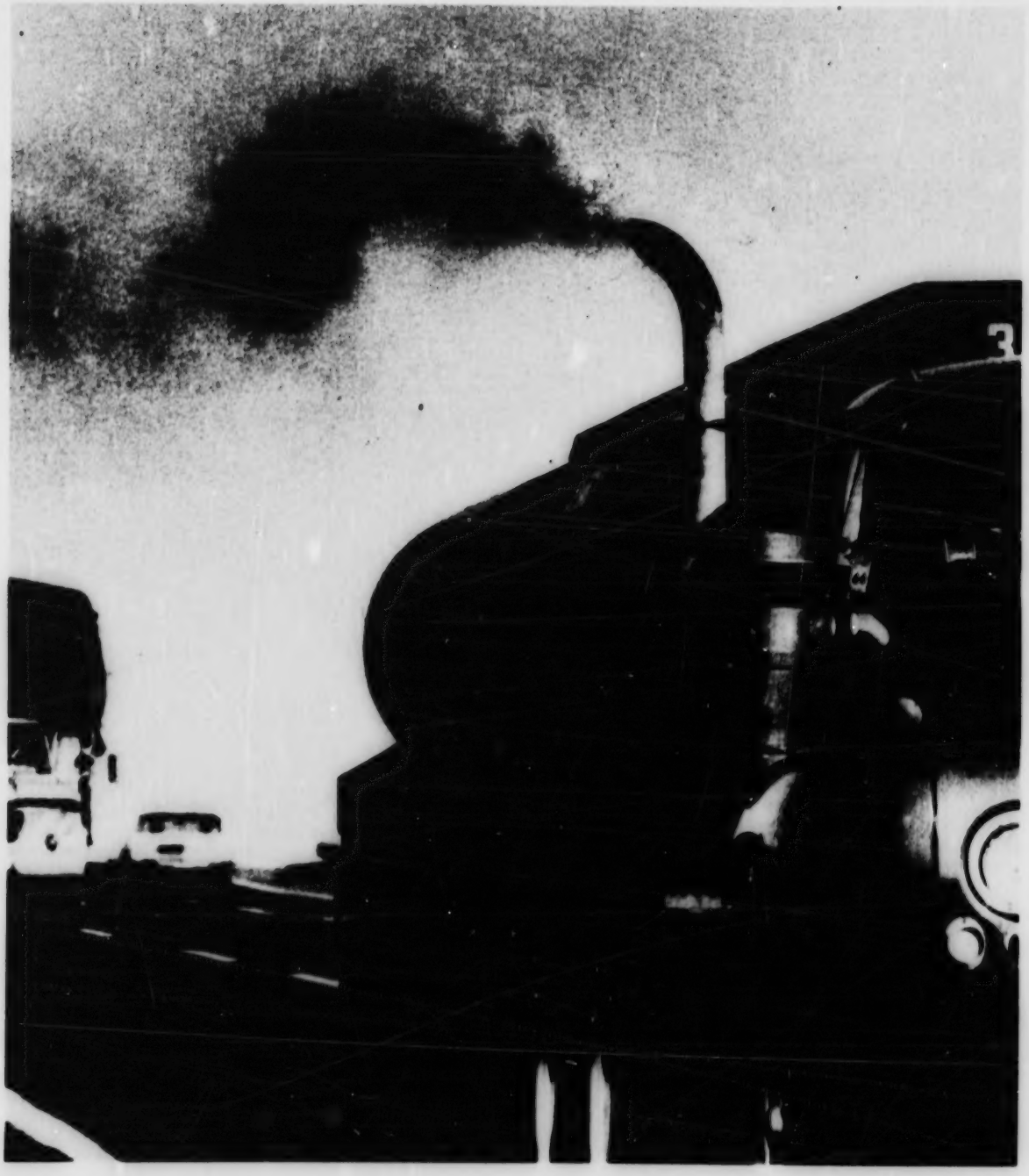
b) Standards apply to the combined emission of hydrocarbon and nitrogen oxides.

Table I.3

MAJOR REGULATIONS PROPOSED/
PROMULGATED DURING FY 1974

DATE	DESCRIPTION	STATUS
Jan. 10,1973	General Availability of Unleaded Gasoline	Promulgated
Jan. 10,1973 (amended Nov. 28, 1973)	Reduction of Lead in Gasoline	Promulgated
July 2,1973	Interim Emissions standards for 1975 model year Light Duty Passenger Vehicles	Promulgated
July 13,1973	Low Emission Vehicle Certification Regulations	Proposed
Aug. 7,1973	Regulations for Light Duty Diesel Passenger Vehicle	Promulgated
Aug. 7,1973	Regulations for Light-Duty Gasoline Trucks	Promulgated
Aug. 21,1973	Interim Emissions standards for 1976 model year Light Duty Passenger Vehicles	Promulgated
Oct. 12,1973	Regulations for Certification at High Altidues	Proposed
Jan. 17,1974	Motorcycle	Advance Notice
Jan. 25,1974	Regulations for Light-Duty diesel Trucks	Proposed
March 7,1974	Registration of Fuels	Proposed
March 21,1974	Exemptions and Exclusions Regulations	Proposed
March 25,1974	Recall Regulations	Proposed
May 7,1974	Amendment to Increase General Availability of Unleaded Gas in Rural Counties	Proposed
May 7,1974	Extensions and Exemptions from Unleaded Gasoline Regulations	Promulgated
July 3, 1974	Supplemental Notice of Proposed Rulemaking to Advance the Jan.1,1975 Compliance date for retail outlets for unleaded gas in rural counties to Oct.1,1974	Proposed
May 10,1974	Conversion to Non-Methane Hydrocarbon Standards	Advance Notice

CHAPTER II. EPA ACTIONS



EPA has been active in promulgating regulations for heavy-duty truck engines as well promulgating regulations for passenger vehicles.Federal standards through 1970-73 for heavy-duty truck diesel engines covered smoke emissions only. For the 1974 model year, the standards were revised to include HC, NOx. and CO emissions.

CHAPTER II. EPA ACTIONS

A. SUSPENSION OF 1976 NOx EMISSIONS STANDARDS

On July 20, 1973 the Acting EPA Administrator, granted the request of Ford Motor Company, General Motors Corporation, and Chrysler Corporation for a 1 year suspension of the 1976 motor vehicle emissions standards. The 1976 standards are applicable to light-duty vehicles and engines manufactured during or after model year 1976. Section 202(b) of the Clean Air Act requires that 1976 and later model year vehicles and engines achieve a 90 percent reduction in nitrogen oxides over 1971 model year vehicles.[1/] The Administrator's decision to grant the request was made on the basis of four criteria specified in Section 202(b)(5) of the Clean Air Act. The Act states that The Administrator has the authority to suspend for 1 year, the effective date of the 1976 NOx standard only if he determines that:

- o the applicants have established that effective control technology is not available to achieve compliance prior to the effective date of the standards.
- o the study of the National Academy of Sciences (conducted pursuant to the Act) and other available information does not indicate that the technology is available to meet the standards.
- o the applicants have made all good faith efforts to meet the standards.
- o the suspension is essential to the public interst or the public health and welfare of the United States.

On the basis of these criteria, and the information submitted by applicants and other witnesses during 2 weeks of hearings held by EPA, The Administrator decided to suspend for 1 year the effective date of the 1976 standards. The Act also directs that if a suspension is granted,

then EPA must set interim standards representing the best available technology. The EPA Administrator set an interim standard of 2.0[2/] grams per mile of NOx for the 1976 model year vehicles.

On the basis of information submitted during the course of the hearing by the applicants, other foreign and domestic automobile manufacturers, and catalyst and substrate suppliers, EPA determined that the technology was not available for compliance with the 1976 standards. The hearing record indicated that the control of nitrogen oxides for the 1976 model year would involve a reducing catalyst. However, the technical problems associated with reducing catalysts, and the greater complexity of the NOx control system over the oxidation catalyst system used to control HC and CO indicated that the state-of-the-art would not permit meeting standards by the 1976 model year. Reducing catalysts required more precise air/fuel ratios than did oxidation catalysts, they suffered from durability problems, and the integration of the NOx emission control system was more difficult than was obtaining a workable HC and CO emission control system. Although evidence presented by the manufacturers established that progress had been made in developing catalyst sensors at the bench test level, insufficient data existed in the record to support a prediction that the basic technical problems of durability and system integration could be overcome by the 1976 model year.

Evidence was also presented at the hearing indicating that the Honda and CVCC engine could achieve the statutory 0.4 NOx level on light-weight cars. However, the CVCC engine had not demonstrated its capability to control NOx emissions on heavier cars, and insufficient lead-time existed to convert a significant fraction of the engine production lines to CVCC technology by the 1976 model year.

The National Academy of Sciences (NAS) also confirmed that the technology was not available to reasonably predict success in meeting the 0.4 NOx standard on 1976 model year vehicles. The NAS report conducted under the Clean Air Act, concluded that no vehicle equipped with a dual catalyst system (oxidation and reducing catalyst) had exhibited the necessary durability to meet the 1976 standard, and that there was no certainty that such technical problems could be solved by the manufacturer in time for the 1976 model year.

With respect to the good faith requirements of the Act, EPA determined that the manufacturers had made "good faith" efforts toward achieving the 1976 standard although the record indicated that there did appear to be a lack of cooperation between manufacturers and suppliers. Each applicant for a suspension request was determined to have spent extensive funds on research and development of NOx control technology. This factor, coupled with the fact that the manufacturers were progressing toward meeting the 1976 standard at the same rate they had been progressing toward meeting the 1975 HC and CO standards, enabled EPA to find that the manufacturers had met the good faith requirements of the Act.

EPA also determined that granting a suspension for 1 year of the effective date of the 1976 motor vehicle emission standards would be essential to the public interest. EPA had determined that the technology was not available to enable compliance with the 1976 standards by the 1976 model year. Consequently, granting a 1 year's suspension would be in the public interest since without available technology, the auto industry would be forced to shutdown if a suspension were denied, and the technology was not available. Evidence was also presented indicating that the sale of 1 year's vehicles meeting the interim standard set by EPA would not significantly increase

NOx emissions, or significantly impact air quality levels. Although two other factors touching on the public interest issue were surfaced at the hearing, insufficient evidence existed to make a conclusive finding or to enable these factors to weigh heavily on the public interest decision. Information received in the hearing record indicated the possibility that reduction catalysts might impose significant fuel economy penalties, and that HC and CO emissions due to reduction catalysts might increase.

B. MOTOR VEHICLE REGULATIONS

A number of EPA regulations proposed and promulgated during the year will also help reduce air pollution from motor vehicles.

1. Regulations for Light-Duty Diesel Passenger Vehicles

Regulations for the control of exhaust pollutants from diesel-powered light-duty passenger vehicles to be effective with the 1975 model year were promulgated on August 7, 1973 (38 F.R. 21348). Currently, about 8,000 of the approximately 10 million light-duty vehicles sold in the United States are diesel-powered. Due to the ease with which these vehicles can be made to meet emission standards and their inherently excellent fuel economy, the proportion of diesel-powered light-duty vehicles is expected to increase. These vehicles will nowbe required to meet the same emission standards that are applicable to gasoline-fueled light-duty vehicles.

2. Regulations for Light-Duty Gasoline Trucks

Regulations for control of emissions from light-duty gasoline fueled trucks, effective with the 1975 model year, were promulgated on August 7, 1973 (38 F.R. 21363). (A light-duty truck is defined as any motor vehicle weighing 6,000 pounds or less, which is designed primarily for transporting property or is a derivative of such a vehicle, or has

special features enabling off-street operation.) This action was in response to the U.S. Court of Appeals decision regarding emission standards for 1975 model year light-duty vehicles (International Harvester Company vs. Ruckelshaus, D.C. Cir No. 72-1517, Feb. 10, 1973) in which the Court ordered EPA to remove light-duty trucks from the light-duty vehicle category. The new emission standards for light-duty trucks are significantly more stringent than the 1974 standards, but are slightly less stringent than the interim 1975 standards for light-duty vehicles.

3. Regulations for Light-Duty Diesel Trucks

Regulations for the control of diesel-powered light-duty trucks were proposed on January 25, 1974 (39 F.R. 3276). Currently, no such vehicles are known to be marketed in the United States. However, prior to this proposal, at least one manufacturer notified EPA of plans to market a light-duty diesel truck.

The standards contained in the proposal are the same as those promulgated for light-duty gasoline-fueled trucks and are expected to be met through application of existing technology. The standards would be applicable beginning in the 1976 model year.

4. Motorcycle Regulations

An Advance Notice of Proposed Rulemaking to control emissions from new motorcycles was published on January 17, 1974 (39 F.R. 2108). The need for control of motorcycle emissions stems from the increasing number of motorcycles in the urban environment and their relatively high emission levels compared to new cars. The Advance Notice of Proposed Rulemaking communicates to motorcycle manufacturers the course of action EPA is considering regarding the stringency and timing of motor-

cycle regulations, thus providing them with the maximum possible lead time, and also seeks comments on technical aspects of the regulations.

Many factors--for example, increased personal income, increased leisure time, improved products and greater general public acceptance--have caused the motorcycle population to expand sharply over the past few years. EPA estimates that 2.3 million motorcycles will be offered for sale in 1976, compared with a projected 12 million automobiles. On the average, an uncontrolled motorcycle emits 20 times more hydrocarbons per vehicle mile than an automobile controlled to the 1977 standards. The average motorcycle however, annually travels only one-third the miles of the average automobile. Based on these data, the new motorcycles sold in 1976 and thereafter will, if left uncontrolled, add a greater hydrocarbon burden to the atmosphere than all new automobiles sold in each of those years.

In addition, the proposed rulemaking for the Approval and Promulgation of Implementation Plans (40 CFR Part 52) for the States of Arizona, California, and New Jersey includes certain limitations on the registration and operation of motorcycles. These limitations are necessary to reduce total hydrocarbons and carbon monoxide levels in those regions and to prevent a counterproductive shift from automobiles to motorcycles as a result of other elements of the control strategy. The proposed rulemaking states, "In an attempt to remove the ceiling on motorcycle registration, the Agency will evaluate the feasibility of establishing emission standards for new motorcycles and will evaluate the availability of motorcycle emission control technology for meeting emission standards for retrofit." In comments submitted to EPA in response to this proposed rulemaking, the motorcycle industry stated that technology is

available and can be implemented with reasonable production lead time.

5. Non-Methane Hydrocarbon Exhaust Emission Standards

On May 10, 1974, an Advance Notice of Proposed Rule Making was published for conversion of current standards for motor vehicle hydrocarbon exhaust emissions to a nonmethane basis (39 F.R. 16904). This action was in response to a formal petition by Ford Motor Company for such an amendment.

The rationale set forth in Ford's petition may be summarized as follows: (1) Methane is a photochemically non-reactive hydrocarbon; (2) Catalyst-equipped vehicles are likely to have a greater proportion of methane in their exhaust than current vehicles; (3) Current standards limit emissions of all hydrocarbons including methane, thereby penalizing catalyst-equipped vehicles; and (4) this penalty creates a hardship by making it more difficult to control NOx and causing fuel economy to suffer.

Ford did not provide any evidence to support its contention of hardship and informal contacts with other manufacturers indicated a difference of opinion on the need to adopt a non-methane based standard. Therefore, EPA's position is that additional information justifying the need for the change is required before it can embark on a program to develop regulations. The Advance Notice of Proposed Rulemaking is aimed at obtaining the comments of other manufacturers and interested parties so as to allow EPA to base its decision on the merits of the issue.

6. Revision of Motor Vehicle Cerification Regulations

On February 27, 1974, the Agency promulgated regulations designed to accomplish three main purposes: (1) to clarify certain requirements pertaining to vehicle emissions certification and provide that certification may be denied (or revoked) on account of a failure

to comply with such requirements (principally, the requirements provide for the right of entry into manufacturers' facilities for EPA personnel in order to perform inspections); (2) to clarify that the Administrator will not certify any vehicles employing Auxiliary Emission Control Devices which have been determined by the Administrator to be "defeat devices", and (3) to provide that once the regulations are in effect production vehicles which do not conform in all material respects to the same design specifications that applied to a certification vehicle will not be covered by the certificate of conformity.

The regulations spell out in much greater detail than previously the kinds of records a manufacturer of motor vehicles or engines must compile and keep, and the kinds of inspections it must consent to in connection with certification and production facilities. They also state explicitly that failure to comply with any of these requirements may result in a denial or revocation of certification for vehicles affected by the failure. Finally, they provide that all these record-keeping and inspection requirements apply to facilities and manufacturers located overseas just as much as those located in this country.

7. Regulations Defining Certificate of Conformity

The Certificate of Conformity is issued by the EPA Administrator to manufacturers of motor vehicles upon completion of emission and durability testing of prototype vehicles. Every automobile sold in the United States must have a valid certificate stating that the motor vehicle complies with all applicable Federal motor vehicle emission standards in effect at the time. EPA will propose regulations to define the degree of similarity required between prototype vehicles and their production counterparts. This regulation is a clarification of the language

of the Motor Vehicle Certification Regulations of Feb 27, 1974 (#6 above), and will allow EPA to more closely control changes to production vehicles that manufacturers may make. Manufacturers in turn will be able to make changes with more confidence that the validity of the Certificate of Conformity will not be affected. The regulations include a list of "critical vehicle configuration parameters" which if changed, would affect exhaust emission levels.

8. Regulations for Certification at High Altitudes

On Oct 12, 1973, EPA published a Notice of Proposed Rule-Making which would require that new motor vehicles offered for sale in high altitude regions of the Nation, be certified for compliance with Federal emission standards at high altitudes (38 FR 28302). Under the current certification process, vehicles are tested in Ann Arbor, Mich., at essentially sea level conditions; those complying with the standards may be sold anywhere in the Nation, including areas at high altitudes. The Clean Air Act requires that all new vehicles, wherever sold or operated, meet Section 202 emission standards. EPA has proposed these regulations because its studies of comparative emission levels of various United States cities show that vehicles at high altitude have higher emissions than those same vehicles at low altitude. For 1968 through 1971 vehicles tested in Denver, carbon monoxide and hydrocarbon levels were 60 percent and 50 percent respectively, above the national average.[3/] Three air quality control regions at high altitudes--Denver, the Wasatch Front (Salt Lake City, Odgen, and Provo, Utah), and El Paso, Texas/Las Cruces Alamogordo, New Mexico--have ambient air levels high enough to require transportation controls. Substantial improvements in ambient air

quality in these regions are expected to come from the new Federal emission standards for autos if new autos are equipped to meet the emission standards at high altitude.

The additional cost to the automobile manufacturer for each vehicle sold at high altitude is estimated at a maximum of $14 to $19. This includes: 1) an estimate by EPA of $4 per vehicle for additional certification costs and 2) estimates by an automobile manufacturer and the National Academy of Sciences which gave a range of $10 to $15 for the cost of a device which would automatically adjust the engine for correct operation at any altitude up to about 6,000 ft. Such automatic altitude sensing and adjustment devices, however, are not required. If the vehicle is only made to meet the standards at high altitudes the additional cost per vehicle of these regulations beyond the $4.00 per vehicle additional certification costs is expected to be negligible.

9. Regulations for Certification of Low-Emission Vehicles

The purpose of regulations for certification of low emission vehicles is to encourage development of vehicles with significantly lower emission levels than vehicles certified to meet Federal emission standards. Vehicles so certified are then eligible for purchase by the Federal Government at premium prices. The present vehicle certification regulations are applicable to 1973 and 1974 model year light-duty vehicles. On July 13, 1973, EPA proposed regulations extending the provisions to 1975 and later model year light-duty and heavy-duty vehicles (38 F.R. 18686). Comments received in response to these proposed regulations have raised serious difficulties in promulgating certification regulations for low emission heavy-duty vehicles. The primary difficulty is the lack of appropriate test procedures

and test instrumentation for certification. Resolution of the technical difficulties is expected shortly.

10. Regulations Defining Exclusions and Exemptions

On March 21, 1974 EPA proposed regulations defining which motor vehicles are subject to the requirements of the Clean Air Act. (See also Chapter V).

Essentially the regulations provide:

- o criteria to be used in interpretation of the term "motor vehicle" as defined in Section 213(2) of the Clean Air Act.
- o types of exemptions allowed under Section 203(b) and 203(c) of the Act.
- o procedures by which EPA will administer the granting of such exemptions.

These regulations will save the manufacturer costs of installing certified engines in vehicles which are excluded or exempted from the Clean Air Act requirements.

11. Recall Regulations

Recall regulations were proposed for comment on March 25, 1974. They are designed to provide for procedures to implement the recall provisions in Section 207(c)(1) and (2) of the Clean Air Act. The Act requires that when a vehicle or engine manufacturer is notified that a recall order has been lodged against him, he submit a plan to remedy the emissions problem. This plan includes notification of owners that their vehicles (or engines) should be brought to repair facilities and that the vehicle (or engine), if properly maintained and used, will be serviced at no expense to the owner. The manufacturer may request a hearing to contest the recall decision. The recall regulations implement these statutory requirements by describing the content of the re-

medial plan and owner notification letters. Furthermore, the regulations describe the reports that a manufacturer must submit to allow the Administrator to evaluate the effectiveness of the recall campaign. Finally, formal hearing procedures are included in the regulations to provide the manufacturer a public forum in which to contest a recall decision. (For additional information on the recall program see Chapter V).

12. Regulations for Importation of Catalyst-Equipped Vehicles

EPA plans to amend current regulations governing the importation of motor vehicles and motor vehicle engines. (Subpart P, Part 85 of Title 40 of the Code of Federal Regulations). The purpose of the amendment is to assure that vehicles equipped with catalyst converters and imported into the United States after having been driven abroad on leaded gasoline are brought into conformity with U.S. emission standards. This is necessary because lead in gasoline deteriorates the catalyst.

EPA proposes to deny entry to catalyst-equipped motor vehicles which have been operated in countries where unleaded fuel is not available. Conditions of exception to this denial of entry are:

1) An Internal Control Program by the Vehicle Manufacturer which must be approved by EPA. This program will insure that a catalyst is initially installed or replaced upon importation of vehicles sold under this control program. The cost to the manufacturer has not been assigned any dollar estimates but involves costs to the manufacturer of developing and administering the internal control program;

2) An Internal Control Program developed and administered by the State Department and the Department of Defense for their

own personnel;

3) Posting of a Bond by the Individual Importer. (Generally an individual consumer) This involves posting of a temporary bond by the importer equal to the value of the vehicle plus duty. The bond is released once a new catalyst is installed or a contaminated one replaced.

C. Fuel Regulations

1. Fuel Regulations for Lead-Free Gasoline

Fuel Regulations were promulgated January 10, 1973 to insure that lead-free gasoline would be available to owners of automobiles equipped with catalytic converters. Availability of lead-free gasoline (gasoline in which the amount of lead does not exceed .05 grams of lead per gallon) is necessary because lead in gasoline deteriorates the catalytic converter components.

The regulations require that all gasoline stations selling more that 200,000 gallons annually offer unleaded gas for sale at at least one pump by July 1, 1974. On May 7, EPA issued a Notice of Proposed Rulemaking to increase the general availability of unleaded gasoline in rural counties. This required that gasoline stations selling over 150,000 gallons annually and located in counties having a population density of less than 50 people per square mile, offer unleaded gasoline for sale. A Supplemental Notice of Proposed Rulemaking was published July 3, 1974 which proposed to advance the January 1, 1975 compliance date for rural counties to October 1, 1974.

There is a small additional cost to the manufacturer of 0.1 cent per gallon above the combined cost producing regular and premium gaso-

line. There is an additional cost of 0.5 cent per gallon to the industry for distribution and marketing of lead free gasoline.

2. Fuel Regulations for Low-Lead Gasoline

On January 10, 1973 EPA promulgated regulations requiring the amount of lead in gasoline to be reduced to an average of 1.25 grams per gallon by January 1, 1978. On November 28, 1973, EPA announced that revised lead regulations had been promulgated which provided for a phased reduction in the average lead content of all grades of gasoline produced by any refinery over a 4 year period. Refineries are restricted to 1.7 grams per gallon beginning January 1, 1975, with annual reductions to 0.5 grams per gallon by January 1, 1979. The incremental gasoline production costs vary from zero in the first several years to a maximum of 0.1 cents per gallon of gasoline in 1979. Reporting requirements necessitated by these lead phase down regulations impose a minimal additional cost to refiner or lead additive manufacturer.

3. Regulations for Registration of Fuels and Additives

On March 7, 1974, EPA proposed additional regulations to establish procedures to obtain basic information about fuel and fuel additives. Such information is needed to determine the effects which additives or their combustion products may have on emission control devices (particularly catalytic converters) or on the public health or welfare.

The proposed regulations prohibit the sale, or introduction into commerce, of fuels or fuel additives designated by the EPA Administrator after specified dates, unless such fuels or fuel additives have been registered with EPA.

To register fuels or fuel additives, the manufacturers must submit information as specified in the proposed regulations, and, in some cases, perform tests to determine potential public health effects of the fuels or additives in accordance with protocols and procedures to be established by EPA. For additives, such information includes their chemical composition. For fuels, it includes the commercial name and manufacturer of any additive contained in the fuel, the range of concentration of any additive in the fuel, and the purpose-in-use of any such additive. Other information, such as chemical and physical properties of a fuel, is also to be furnished.

The cost to the fuels manufacturer in conforming with these regulations is estimated as the cost of submitting initial information and quarterly updating information. The cost of initial notification is estimated as $150,000 and annual updating costs are estimated at $350,000. The cost to the fuels additive manufacturer is the initial reporting cost estimated at $25,000-30,000 and the cost for reporting new additives estimated at $2,000 per year.

CHAPTER III. PROGRESS IN EMISSION REDUCTION TECHNOLOGY

During the 1973/74 fuels shortage, mobile source emissions were reduced and air quality improved in some localities as motorists cut down on highway driving. EPA is currently exploring alternative power systems and fuels to alleviate the problem of relying predominately on gasoline. DOCUMERICA-Bob W. Smith

Chapter III. Progress in Emissions Reduction Technology

A. Alternative Automotive Power Systems Program

During the past year, EPA continued its program to evaluate and develop alternative automotive power systems (AAPS) to the conventional internal combustion engine. The evaluations of alternatives coming from this program are expected to provide factual information to Federal policy makers, Congress, and the American public on what can and cannot be accomplished in automobiles with respect to achievement of low emissions, good fuel economy, and satisfactory road performance.

The program began in July 1970 with preliminary technical evaluations of known power systems. These initial evaluations resulted in a ranking of the systems primarily on the basis of their potential (if developed) for achieving what are now the statutory 1978 Federal emission standards. This ranking was followed by preliminary design studies on the highest ranked systems. In 1971 further evaluations of all the designs provided added confidence that the three highest ranked systems should proceed into hardware development.

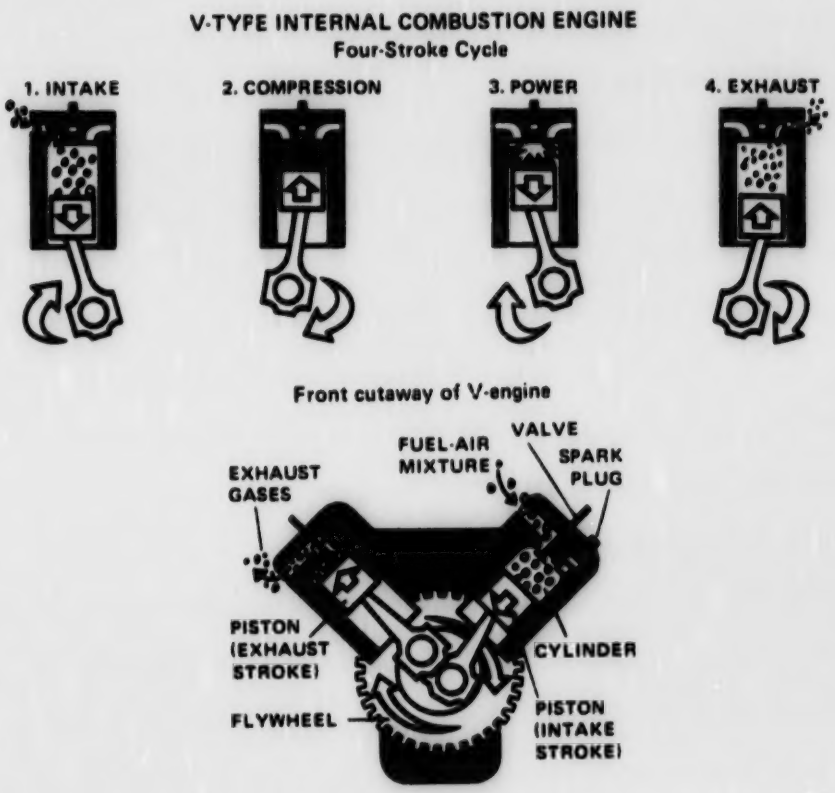
The three types of systems being developed were the internal combustion engine employing the stratified charge combustion process, the gas turbine engine, and the Rankine cycle engine.

1. Conventional and Stratified Charge Engine

The gases emitted by automobile exhaust are the waste products of combustion. In a typical automobile, gasoline (a hydrocarbon fuel) is fed from a tank to a carburetor where it is mixed with air. This mixture is then drawn into the cylinder, where it is compressed and ignited by the spark plug (Figure III. 1), the resulting explosion forces

the piston down the cylinder. This is the power stroke which is transmitted through various shafts and gears to drive the car. When the piston is at the bottom of its down stroke, the cylinder is full of hot gases--unburned hydrocarbons, carbon monoxide, nitrogen oxides, and carbon dioxide--water, particles of lead, and other compounds. Then the piston rises to expel the remaining gases through an exhaust valve, and the cycle is repeated. This action is repeated in each of the engine's cylinders.

Figure III-1
Internal Combustion Engine



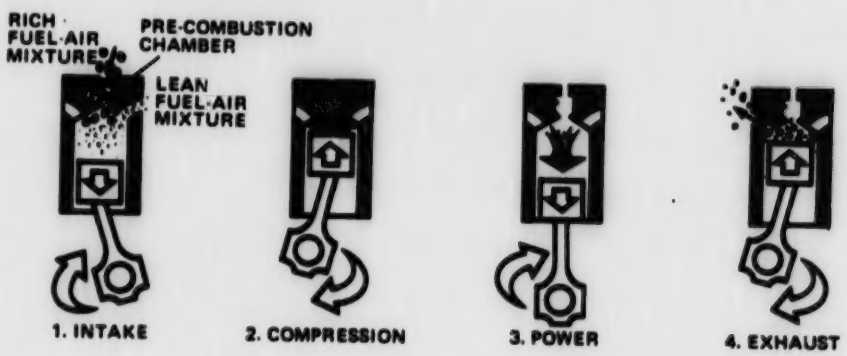
Illustrations in this section are highly simplified schematics to show only pertinent functions.

The stratified charge engine is a refinement of the conventional engine that features a more efficient combustion process. This engine is spark ignited, gasoline fueled, and uses much of the hardware of the conventional engine, with the difference that a "layered" or "stratified" fuel mixture is used in the combustion chamber. The central idea is to supply a rich mixture of fuel near the point of ignition inside the cylinder, but keep the rest of the mixture lean.

One type of stratified charge engine that has been developed uses a small precombustion chamber in the cylinder head (Figure III. 2). The small chamber which contains the spark plug, is supplied a rich air fuel mixture by one carburetor through the third valve. A lean air mixture is supplied by the other carburetor to the normal chamber through the normal intakes. The rich mixture in the small chamber provides good ignition, and the flame spreads to the lean mixture. Burning the cylinder is slower and more efficient than in conventional engines and by prolonging the combustion, most exhaust pollutants are burned up inside the cylinder.

Figure III. 2

Stratified Charge Engine System



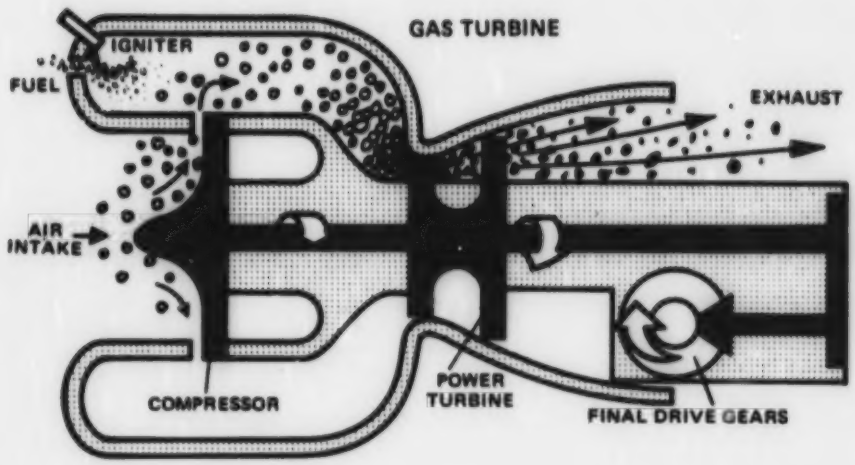
The stratified charge engine is no longer a part of the AAPS program. In 1973 the technologies associated with this process had progressed to an advanced phase of development beyond the scope of the AAPS program. The original AAPS work on the stratified charge process was in direct support of an ongoing U.S. Department of the Army program aimed at applying this combustion process to Jeep engines. The Army has continued with the development of the stratified charge process to the point where engines are being "soft tooled" for limited production, test, and evaluation. In addition, one manufacturer plans to market 1975 model year automobiles equipped with stratified charge engines. This same manufacturer is the only manufacturer who did not apply for suspension of the 1975 statutory standards.

2. Gas Turbine Engine

In conventional engines, the basic combustion process of compression, heating, and expansion occur successively in the same component--that is, one cylinder. In the gas turbine engine, on the other hand, the processes occur simultaneously and continually in different components--that is compressor, combustor, and turbine. Air is taken in by the compressor, compressed to a higher pressure and then delivered to the combustion chamber where it is mixed with fuel and burned. The resulting high-temperature, high-pressure gas runs the turbine (Figure III.3). Part of the shaft power developed by the turbine is used to drive the compressor; the remainder is the output used to drive the vehicle and the accessories.

An advantage of the turbine is that combustion can be adjusted for very efficient burning of the fuels, thus minimizing pollutants in the exhaust.

Figure III.3
Gas Turbine Engine



Gas turbine development research has progressed well over the past year. Significant work is underway at solving three current problems: relatively high emissions of NOx, poor fuel economy, and high manufacturing cost.

During the past year, seven engines have been built, and three installed in automobiles. The engines have been run on engine dynamometers by contractors and by the NASA Lewis Research Center in Cleveland, Ohio. Complete engine performance curves (e.g., plotting horsepower versus revolutions per minute) have been obtained from this testing. Vehicle performance also has been documented from road and chassis dynamometer testing. These data have provided a baseline on which improvements are being made in the three problem areas.

The development of a low emission combustor (means by which energy is added to the system) continued. The new hardware has evolved from test equipment used earlier in lab tests. These tests proved that the combustion concept, which uses a variable geometry combustor with pre-vaporization and pre-mixing of the fuel and air, can achieve emission levels (NOx included) lower than the statutory levels. The test combustor has been successfully run when installed in the complete engine mockup and is being shipped to the contractor for further tests in the vehicle. The combustor is large, and size reduction will be emphasized in future development work.

Work to improve fuel economy is progressing in many areas. For example, the new and improved designs have been completed for all aerodynamic components. Tests have been conducted to verify the use of water injection as a means of boosting power and permitting use

of a smaller basic engine size. The new designs for variable inlet guidevanes also have been completed. Work is continuing on finding ways to reduce and to recover heat losses occurring within the turbine. In total, the effects of these changes when implemented with hardware could mean a 50 percent improvement over fuel economy of current gas turbines which would bring fuel economy of gas turbines in line with that of conventional engines.

In addition to working on these methods within the engine for improving fuel economy, work was initiated on another important area outside of the engine itself. This new work is focusing on the development of a continously variable transmission. If successful, this type of transmission could improve the vehicle fuel economy as much as 30 percent over the already improved gas turbine.

Manufacturing costs will be reduced both from use of ceramic material and advanced casting techniques for making rotating components. With the assistance of the Department of Defense and the National Aeronautics and Space Administration, all ceramic work elsewhere in the United States is under review; promising materials will be made available to the EPA program as soon as possible. Development work sponsored by the program on ceramic heat exchangers continued during the past year, with a new project to test and evaluate all known ceramic heat exchangers planned to begin in the Fall of 1974.

The project to develop new and low cost casting techniques also continued during the past year. In areas relating to new materials and manufacturing techniques, progress has been typical of this type of work--steady but slow.

The upgraded version of the engine embodying all of the improve-

ments noted here will be used to determine the overall improvement in emissions, fuel economy, and manufacturing costs. A potential health problem of nickel oxide emissions from gas turbine engines equipped with nickel oxide rubbing seals has been identified. Efforts have been initiated to develop alternative seal materials.

3. Rankine Cycle Engine

The Rankine cycle system is an external, continuous combustion engine in which high pressure steam or other working fluid vapor is expanded in either a turbine or a piston-type expander to produce work. A pump draws liquid from a condenser and forces it under high pressure into the vapor generator, where it is converted to superheated vapor by the heat from combustion in the burner. The hot, high-pressure vapor is then metered into the expander where it produces usable power. The vapor expands to a low pressure and is then cooled and converted back to a liquid in the condenser. The resulting low-pressure liquid is then returned to the vapor generator by the pump to repeat the cycle.

During FY 1973, four versions of the Rankins cycle were under pre-prototype system development and were in competition for selection as the prime system and the backup system to be developed in the prototype phase. These four versions covered use of organic materials and water as working fluids and reciprocators and turbines as the expanders. Since fuel economy is an imporant factor in any change in engines to be produced for the consumer, strong emphasis was placed on improving this characteristic.

Three of the four systems were tested on engine dynamometers and the

test data evaluated. In particular, the various versions of Rankine cycle were compared on the basis of their emissions and fuel economy for the pre-prototype version and on the projected weight, volume, size, and complexity for the prototype version of each.

All of the engine versions displayed very low emissions, as expected from the basic Rankine cycle combustion process (atmospheric pressure and temperature). The fuel economy of both turbine versions was relatively low becasue of inefficiencies at low loads. The organic turbine was considerably larger than the water turbine, mainly because of the size of the heat exchangers. These evaluations led to the selection of the water reciprocating (steam) system as the prime system and the organic reciprocating system as the backup.

The work on the steam engine will continue on the engine dynamometer, with emphasis on developing the control system and on further improving fuel economy. Current plans call for a complete engine system to be installed in a vehicle with the purpose of completing of development of the control system. The vehicle, a full sized car, will be tested on a chassis dynamometer late in 1974. In addition to vehicle oriented work, component development is proceeding in the areas of freeze protection and in the overall reduction and recovery of waste heat. The work on the back up system will be limited to engine dynamometer testing to further develop the control system and to improve fuel economy.

4. Demonstration Vehicles

By the Fall of 1972 development of the gas turbine and Rankine cycle systems had progressed to the point where laboratory tests showed

that what are now the 1978 model year statutory levels had been met. EPA felt that continued refinement of the concepts demonstrated that stringent emissions would be met when combustor hardware appeared in demonstration vehicles. As a result, program development activities focused on fuel economy. The 1970 plans originally called for complete system testing and demonstration in automobiles by 1975, followed by final evaluations. These demonstrations were to be made in full size automobiles of about 4,500 pound test weight, the size most often purchased.

In 1973, to further emphasize the importance of fuel economy and to encourage greater use of smaller automobiles, the demonstration size vehicles were changed to compact size (3,500 pounds maximum). Work is now proceeding on the smaller engines required. As a result of this change, system demonstrations have been moved back approximately 6 months with demonstrations planned in FY 1976.

B. Federal Clean Car Incentive Program

The Federal Clean Car Incentive Program (FCCIP) is designed to promote private development of new types low-emission vehicles capable of meeting what are now the 1978 model year emisssion standards. The program offered financial assistance to private manufacturers engaged in developing low-emission prototype vehicles. The first phase of the program consists of a developer leasing to the Federal government a candidate prototype vehicle which is subjected to rigorous evaluation by EPA. After a prototype successfully passes the stringent emissions and performance testing, EPA may purchase 10 more prototype cars for more comprehensive testing. The Government may later buy up to 500 vehicles for further evaluation and limited fleet use.

The program began in January 1971 with 20 initial proposals from industry. Seven different vehicle systems were accepted into the program. Four withdrew prior to FY 1974; one more entry withdrew during the past year because of failure to achieve the required emission levels coupled, with lack of corporate finances to continue the development. Thus far two types of prototype vehicles have been delivered and tested.

One vehicle tested was in internal combustion engine car with catalytic exhaust treatment and exhaust gas recirculation (EGR). The emissions often met the 1978 model year standards but were not consistent. Durability was not acceptable, and several catalytic converter replacements and catalyst additions were required during testing. This car was not accepted for the second phase of the program.

The second prototype car delivered and tested was a hybrid heat engine/battery car using a Wankel engine with thermal reactor and exhaust gas recirculation and an array of lead-acid batteries. Emission levels in test samples were sometimes quite low, but were not consistent. This inconsistency was at least partially due to the relatively undeveloped carburetion controls used in the prototype vehicle. Fuel economy on the city driving cycle used in certification testing was similar to other 1974 vehicles at the same inertia test weight. Some relative improvement in fuel economy was indicated in several highway mode tests. The complete test results for this system are under evaluation. Additional tests appear to be needed before completing the evaluation and making recommendations for or against continuing this vehicle in the FCCIP.

Much has been learned from formulating and implementing this program. Specifically, EPA has found that it is extremely difficult to provide adequate financial incentive to independent developers of new engine systems under conditions where the Federal Government would purchase, test and evaluate only the end product of a developer's efforts. Considerable monies (amounting to several millions of dollars) must be available to the developer during development of the hardware, rather than after development is completed. Currently, EPA is aware of no mechanism in the Federal Government to support this type of work other than by normal Federal R&D contract procedures. In this case, the development would be part of a Federal program and not a privately sponsored program, as was the original intention of the FCCIP. Thus, FCCIP cannot provide enough financial incentive to compensate independent developers for the financial risks they must take. As a result, the program will be terminated after evaluations are completed and recommendations made on the one remaining car.

C. Low-Emission Vehicle Purchase Program

Section 212 of the Clean Air Act provides for the creation of a Low Emission Vehicle Certification Board. Upon submission of an application, the EPA Administrator must determine whether or not a vehicle qualifies as having emissions substantially lower than standard levels. The Board then has the responsibility for certifying whether a vehicle is suitable for use as a substitute for any class of vehicle then in use by the Federal Government. Certified vehicles may be purchased for use in Government fleets at premiums ranging up to 100 percent over prices normally paid by the Government for equivalent vehicles.

Three applications have been received for certification under Section 212, all covering electrically powered vehicles. The EPA Administrator has determined that the vehicles described in these applications are powered by inherently low-polluting propulsion systems. The LEVCB has met twice during this past year and has rejected the first two applications on the basis that the vehicles covered are not suitable substitutes for any existing class of vehicles currently procured for use by Federal agencies. The third application is being reviewed.

D. Feasibility of Alternative Fuels

The energy crisis brought with it an awareness of the need to reduce consumption of petroleum fuels. In addition, most automotive emission pollution stems from the chemical make-up of petroleum fuel. Recognizing this, EPA initiated contract studies in July 1973 to assess the technical and economic feasibility of alternative fuels that were compatible with objectives of reduced automotive emissions and improved automotive fuel economy. As used here, "alternative fuel" applies to fuels derived from nonpetroleum resources in abundant supply in the United States.

The studies have shown that the most promising alternative automotive fuels are synthetic gasoline and distillates derived from coal. Hydrogen fuel may be possible by the year 2000.

Based on these findings, further work has been initiated to fill identified reaseach and data gaps for the leading synthetic fuels. Under EPA funding, the Bureau of Mines began testing of engine combustion characteristics using alternative fuels in April 1974. Other studies recently initiated include combustion testing of a more fundamental nature through university grants, and studies to assess the impact of United States production, distribution and utilization of the alternative fuels.

E. Assessment of Progress

1. EPA Assessment

More than 70 percent of all 1975 model cars are expected to be equipped with catalysts, a considerably larger number than EPA's earlier expectations. The 49 State interim standards for the 1975 model year (excluding California) permit manufacturers to choose between catalyst and noncatalyst systems. The greater than expected use of catalysts for the 1975 model year is due to the fuel economy advantage they offer.

The sales-weighted fuel economy of the 1975 model year fleet, assuming the same model mix in 1974 and 1975, will be at least 8 percent better than the 1974 fleet (in addition to catalysts, changes in carburetion, lower axle ratios, and electronic ignition systems will contribute to improved fuel economy), according to estimates made by major automobile manufacturers at hearings Nov. 6, 1973 before the Environmental Subcommittee of the Senate Committee on Public Works. Not all manufacturers will achieve gains, and in some cases there will be fuel economy loss.

In meeting past emission standards, most manufacturers used the same basic approach of engine modification (i.e., spark retard, intake manifold preheating and faster acting chokes) and exhaust gas recirculation. The 1975 models will utilize a greater variety of control approaches. Saab, for example, will use fuel injection and no catalyst to meet both the Federal and California interim standards. Honda will use its compound vortex controlled combustion (CVCC) stratified charge engine. Mazda will use a thermal reactor.

Some companies--Mercedes-Benz, for example--may use two different approaches to emission control on the same model. Mercedes plans to equip some vehicles with catalyst and other with thermal reactors.

Thermal reactors may be used because a substantial number of Mercedes sold to U.S. customers are initially purchased and driven in Europe where unleaded gasoline is not generally available. The thermal reactor is not adversely affected by the lead in the gas and will pass U. S. emission standards.

EPA's technical staff have analyzed extensive information provided by automobile manufacturers under the provisions of Section 202(b)(4) concerning their progress toward meeting the Federal emission standards. The paragraphs which follow represent the collective judgement of EPA engineers directly responsible for the interpretation and analysis of the information.

The probability is very high that manufacturers will be able to certify most of the line of vehicles in the 1974 model year at the 0.41 grams/mile HC, 3.4 grams/mile CO, and 2.0 grams/mile NOx levels required by Congress for the 1977 model year. Fuel economy at these levels will depend heavily on the advances made beyond the systems designed to meet the 1975 California interim standards. If manufacturers do nothing but add spark retard to their California systems, there will be some losses of fuel economy on 1977 models relative to 1975 models. If manufacturers are willing to increase the costs of emission control systems, such techniques as improved catalyst formulation and configuration, improved quick-heat manifolds, and improved exhaust gas recirculation can be used to make the average fuel economy of 1977 models as good as or better than that of 1975 models.

Automobile industry research to meet the Clean Air Act statutory levels was drastically reduced during 1973 due to the uncertainty of the necessity of meeting a 0.40 grams/mile NOx standard. The primary obstacle to meeting the standard with reducing catalysts or single bed

oxidation-reduction catalysts appears to be the lack of an advanced fuel metering system. The use of an oxidation catalyst in front of the reduction catalyst shows promise of avoiding sudden increases in oxygen concentration caused by the lack of precise fuel metering for dual catalyst systems. In general, a 0.40 NOx standard, the present legislative target for light duty passenger vehicles, would be expected to solidify the use of catalytic technology.

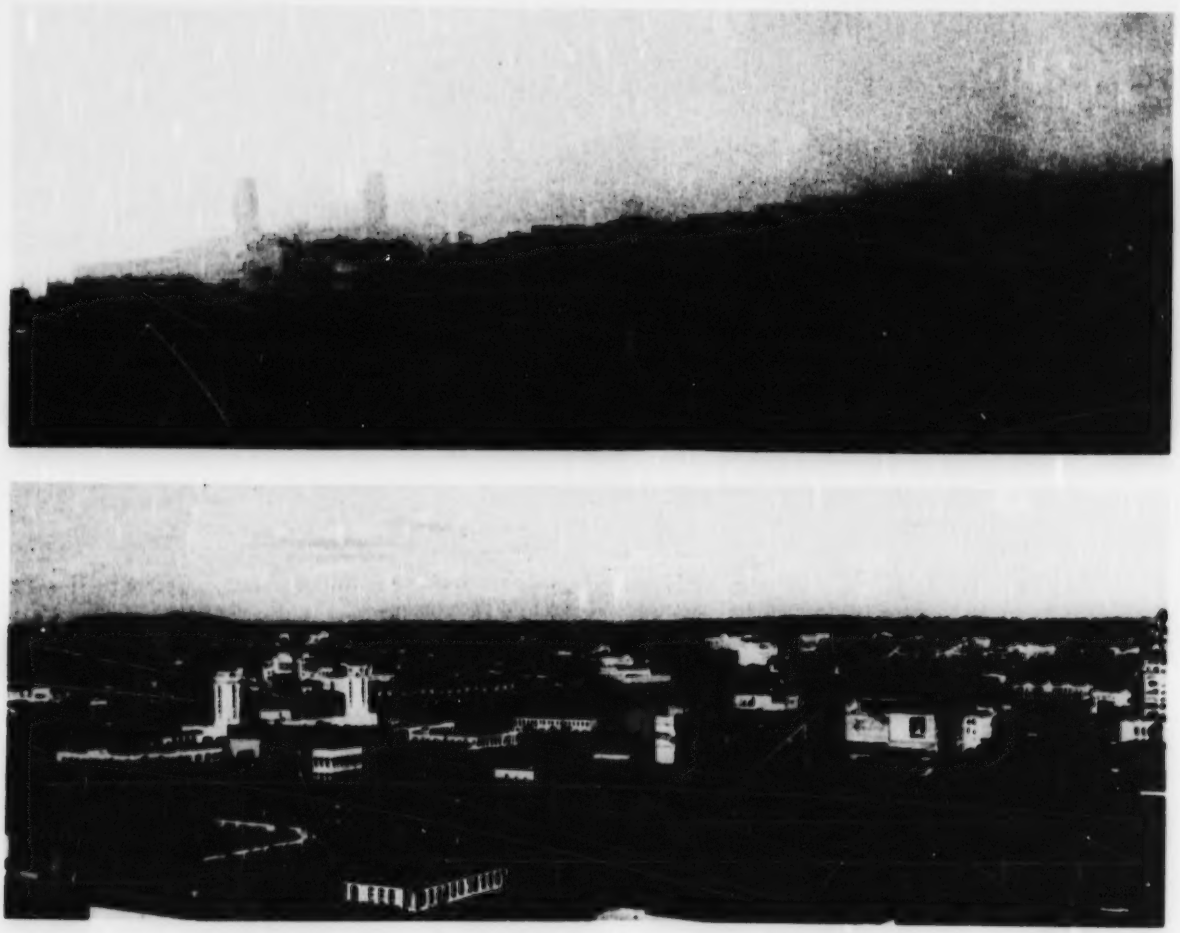
The only manufacturer that has demonstrated the capability to certify at the 1978 standards is Honda with its CVCC engine.

2. National Academy of Sciences Study

The Clean Air Act provided for the National Academy of Sciences to study various aspects of emission control. The Academy's first study reported on the technological feasibility, initial costs, and operating costs of emission control systems designed to operate at the 1975 statutory levels. The findings were summarized in last year' s report.

EPA signed a contract in December 1973 for a second study focusing on the technological feasibility and cost of meeting various NOx emission standards. Other related parameters such as fuel economy, and the relationships between vehicle weight, engine type, and NOx control, are also being investigated.

The final report is due in October 1974.



Visible pollution increases during rush hour traffic in many urban areas. The top picture shows Portland ,Oregon at 9:30 in the morning; the picture below shows Portland at 2:30 in the afternoon. State of Oregon Sanitary Authority

CHAPTER IV. COSTS AND BENEFITS OF MEETING EMISSION STANDARDS

A. Costs of Meeting Emission Standards

1. Light Duty Vehicles

a. Emission Control Equipment--1975-1977 Model Years

The new national Federal standards for HC and CO for the years 1975 and 1976 enacted with the passage of the Energy Supply and Environmental Coordination Act will not necessarily require catalyst equipment to control emissions of light-duty vehicles. The 1975 California standards, however, will require almost all automobiles sold in California to have catalysts. An estimated 70 percent of all 1975 model year cars sold in the United States (including California) will have catalysts. Costs of emission control equipment for 1975-1977 are estimated in Table IV. 1. If 1977 model year standards for HC and CO are not suspended, catalysts will be required on most 1977 model year cars.

b. Emission Control Equipment for 1978 Model Year Light-Duty Vehicles

The capability of many different systems to achieve the statutory 1978 model year standards for NOx has been investigated. At this time, the dual catalyst system has received the most attention because it is compatible with the oxidation catalyst system many manufacturers will use to meet the 1975 California interim standards. No drastic modifications need to be made to the 1975 type system other than installation of the reduction catalyst upstream from the oxidation catalyst. Minor changes include recalibration of the carburetion and different plumbing of the air injection system.[4/]

TABLE IV.1

EMISSION CONTROL EQUIPMENT COSTS,
1974-1977 MODEL YEAR LIGHT DUTY VEHICLES

YEAR	ITEM	LIST PRICE (a)		
		(b) EPA	(c) NAS	(d) INDUSTRY
1974	Cumulative costs through 1974	83.00	54.53	83.00
SOME 1975/76	Quick heat manifold	5.00	4.75	___
	High energy ignition	15.00	12.35	___
	Advanced carburetor	15.00	14.25	___
	Proportional exhaust gas recirculation	20.00	30.00(e)	___
	Air injection	40.00	43.32(f)	___
	Subtotal for noncatalytic systems	95.00	104.67	75-120
MOST 1975/76/77	Oxidation catalytic (includes long-life exhaust system)	90.00	54.70	75-110
	Cooling system changes	___	1.90	___
	Body revisions and material changes	___	2.85	___
	Assembly line changes and testing	___	5.65	___
	Subtotal	90.00	65.10	75-110
	Cumulative costs through 1975/76/77	$268.00	$234.30	$233-313

(a) List price includes both dealer and manufacturer profits.
(b) Economics of Clean Air; Annual Report to Congress, EPA, March 1972.
(c) National Academy of Sciences. Report by the Committee on Motor Vehicle Emissions. February 12, 1973.
(d) Estimated ranges, from domestic manufacturers.
(e) 1974 through 1975 model years.
(f) 1973 through 1975 model years

The estimated costs of emission control equipment for the 1978 model year based on use of a dual catalyst are shown in Table IV. 2. EPA estimates an incremental cost of $80. 00 for addition of a reducing catalyst. Thus, the estimated cumulative cost of equipment per car to meet the 1978 standards is $348. 00

The per-vehicle costs for emission control for light-duty trucks can be considered equivalent to that for passenger cars through 1974, since both types of vehicles are covered by the same standards and the power-plants used are basically the same. With light-duty trucks covered by separate and less stringent standards beginning in the 1975 model year, per-vehicle control costs for light trucks will become somewhat less than for passenger cars.

For this report, it is assumed that costs associated with emission control for light-duty trucks of model years 1975-79 will be the same as costs associated with noncatalytic 1975 passenger-car emission control systems.[5/]

c. Maintenance

Maintenance costs for emission control systems are expected to rise somewhat due to the increased complexity of emission control systems and the addition of oxidation catalysts. However, these costs will be more than offset by the addition of new electronic ignition components that do not need to be changed and by the increase in the life of exhaust system and emission equipment that will result fro n use of lead-free gasoline.

TABLE IV. 2

EMISSION CONTROL EQUIPMENT COSTS
for 1978 MODEL YEAR LIGHT DUTY VEHICLES

YEAR	ITEM	LIST PRICE (a)		
		(b) EPA	(c) NAS	(d) INDUSTRY
	Cumulative costs through 1977	268.00	224.30	273-313
1978	Reduction catalyst	80(e)	74.10	50-90
	Electronic control	____	47.50	15.25
	Sensors	____	5.70	____
	Subtotal	80.00	127.80	65-115
	Cumulative costs through 1978	$348.00	$351.60	$388-428

(a) List price include both dealer and manufacturer profits.
(b) Economics of Clean Air. Annual Report to Congress, EPA, March 1972.
(c) National Academy of Sciences. Report by the Comittee on Motor Vehicle Emission. February 12, 1973.
(d) Estimated Industry ranges.
(e) Revised EPA estimate, April 1973.

The major component of any change in maintenance costs is the possible requirement to change oxidation catalysts in order to maintain acceptable exhaust emission levels. Federal regulations allow one catalyst change after 25,000 miles, but do not require further changes. However, all three major domestic manufacturers have stated that their oxidation catalysts will last the 50,000 mile design life of the car specified by the Clean Air Act. This is a substantial improvement in durability over the early catalysts. As the automobile and catalyst manufacturers have refined their designs, both catalyst efficiency and durability have made significant gains. (Table IV. 3).

d. Fuel Consumption Penalties

In 1973, EPA published the results of an extensive study of passenger-car fuel economy involving tests of nearly 4,000 vehicles ranging from 1957 production models to 1975 prototypes.

EPA data from over 4,000 tests on cars from the 1957 model year through the 1973 model year show that there has been a drop in fuel economy due to emission controls in 1968-1974 cars of about 10% on the average (Table IV. 4) compared to uncontrolled (pre-1968) cars. In 1975, new cars are expected to have a substantial increase in fuel economy; we estimate a 7-8% improvement over 1973/74 cars. This is principally due to the installation of catalysts to lower emissions, which allows the engine to be recalibrated to improve fuel economy.

In addition, installation of electronic ignition systems and the use of lower axle ratios and radial tires help to improve fuel economy. Chrysler, for instance claims fuel economic gains for 1975 model cars of from 3-17% over comparable 1974 models.

Similarly, General Motors has now claimed a 15% overall improvement for its 1975 models compared with 1974.

TABLE IV.3

ESTIMATED INCREMENTAL MAINTENANCE COSTS for
EMISSION CONTROL SYSTEMS OF LIGHT-DUTY VEHICLES (a)

MODEL YEAR	ANNUAL MAINTENANCE COST INCREASE PER VEHICLE
1968-72	$16.00
1973-74	16.00
1975 (b) -76	- 6.00
1977	- 4.00
1978 (c)	+ 4.00

SOURCE: EPA Memorandum: "Analysis of estimated maintenance costs for emission control systems meeting 1975/1976 federal standards, and progress reports on emission control development submitted by Chrysler, Ford and General Motors, November 1973.

(a) Incremental Costs over uncontrolled vehicles.

(b) Based on assumption that 75 percent of 1975 vehicles sold will employ catalystic emission-control systems.

(c) Based on the use of dual-catalyst.

TABLE IV.4

EFFECT OF EMISSION CONTROL ON FUEL ECONOMY OF LIGHT-DUTY VEHICLES

MODEL YEAR	FUEL ECONOMY LOSS, PERCENT
1957-67 (uncontrolled)	Baseline
1968	4.3
1969	5.3
1970	4.7
1971	7.6
1972	7.3
1973	10.1
1974	9
1975 (a)	3
1976 (a)	3
1977 (a)	6
1978 (a)&(b) and subsequent years	7

SOURCE: U.S. Environmental Protection Agency

(a) Less certain than previous years since no firm basis is presently available for estimating.

(b) Based on use of a dual-catalyst system with an advanced fuel-metering system or 3 way catalyst with feed-back control.

If the statutory standards for hydrocarbons (HC), carbon monoxide (CO), and more stringent interim standards for oxides of nitrogen (NOx) are imposed in 1977, then fuel economy may drop again, perhaps as much as 3% from 1975 cars, or a net drop of about 6% over uncontrolled cars. However, this will still be a gain of about 4% over current models. Estimates of the fuel economy impact resulting from imposing the statutory NOx deadlines on 1978 cars range from a slight improvement over 1974 cars to a 9% penalty relative to 1974, depending on the emission control system utilized.

e. Aggregated Costs

The annual total cost is the sum of the pollution control equipment costs on all new cars in that year, the cumulative maintenace costs for all cars sold since 1968, and additional fuel consumed (over uncontrolled cars) by cars with emission controls (Table IV. 5).

2. Heavy-Duty Vehicles

Separate emission control regulations have been in effect since 1970 for new heavy-duty gasoline and diesel truck engines manufactured for use in over-the-highway trucks and buses of over 6,000 lb. gross vehicle weight (GVW). Trucks under 6,000 lb. GVW are considered to be light-duty and have been dealt with in a previous section.

a. Gasoline Engines

The emission control technology used for heavy-duty gasoline engines through 1973 is similar to that employed for light-duty trucks and passenger cars through the 1972 model year. In fact, many heavy-duty gasoline engines are derivatives of passenger-car engines. For 1974, the NOx control standards are generally attainable without the use of exhaust gas recirculation (EGR). However, some EGR engines were certified in the

TABLE IV.5

ESTIMATED NATIONAL COSTS FOR
EMISSION CONTROLS FOR LIGHT-DUTY VEHICLES

ITEM	Annual National Cost $ billions											
	1968(b)	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Equipment	0.05	0.06	0.19	0.35	0.40	1.13	1.01	2.94	3.26	4.03	4.10	4.20
Maintenance(d)	0	0.11	0.28	0.44	0.58	0.76	0.96	1.20	1.31	1.47	1.69	1.92
Fuel-consumption penalties(c)	0.11	0.36	0.50	0.65	1.12	1.76	2.30	2.69	2.89	3.04	3.29	3.54
Fuel price penalties	0	0	0	0	0	0	0.35	0.41	0.43	0.45	0.47	0.49
	0.16	0.53	0.97	1.44	2.10	3.65	4.62	7.24	7.89	8.99	9.55	10.15

(a) Vehicles less than 6,000 lb. GVW including light-duty trucks.

(b) No costs incurred nationally prior to 1968.

(c) Fuel prices assumed: $0.36/gal, 1968/71; $0.40/gal, 1972; $ 0.45/gal, 1973; $0.50 gal, 1974-79. Note that the fuel price figures are low and will affect the estimates.

(d) The annual national costs estimates do not reflect negative maintenance costs for years 1975, 1976, 1977. That means that these figures are higher than they should be.

previous year to meet California standards for 1973, which were at the same level as Federal standards for 1974.

EPA has made no equipment-cost estimates for emission controls for heavy-duty gasoline truck engines. In the absence of such estimates, it is assumed for purposes of this report that the per-vehicle cost increment of 1970-1973 engines is equivalent to that for 1970 model year passenger-car engines less the cost of fuel evaporation controls, or $21.50. It is further assumed that the 1974 and following-year control equipment costs will be equivalent to that for a 1973 passenger car engine, less the cost of EGR and evaporative controls, or $45.50.

Incremental annual maintenance costs for heavy-duty gasoline truck controls for all years are assumed to be the same as passenger-car costs, or $16.

Fuel consumption penalties are estimated to be 3 percent for 1970 and 5 percent for 1974 and beyond.

Aggregated costs are summarized in Table IV.6. The annual total cost is the sum of the pollution control equipment costs on all new engines sold in that year, the cumulative maintenance costs for all engines sold since 1970, and additional fuel consumed (over uncontrolled engines) by engines with emission controls.

b. Diesel Engines

Through 1970-1973, Federal standards for heavy-duty diesel truck engines covered smoke emissions only. In 1974, the standards were revised to include HC, NOx, and CO, emissions as well as more stringent smoke emissions. The permissible gaseous-emissions levels are the same as for heavy-duty gasoline engines for 1974, but the test procedure is

TABLE IV.6

ESTIMATED NATIONAL COSTS FOR EMISSION CONTROL FOR HEAVY DUTY GASOLINE ENGINES

Item	Incremental Cost for Calendar Year, $ millions									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Equipment	14	14	17	23	39	39	39	39	39	39
Maintenance	0	7	18	30	46	61	74	86	98	108
Fuel-consumption penalties	8	20	37	63	92	123	154	184	212	239
Annual total	22	41	72	116	117	223	267	309	349	386

different.

Both smoke and gaseous standards, including those for 1974, have been attainable largely through fuel-injection system modifications. (NOx and smoke are the more difficult emissions to control; even uncontrolled diesels are usually well within CO standards). Equipment cost penalties are considered nominal; further, it is estimated that no fuel consumption penalties have been incurred. Accordingly, no national cost penalty is attributed to diesel-truck engine emission controls.

3. Lead-free Fuel Regulations

On January 10, 1973 EPA promulgated regulations requiring that gasoline stations make lead-free gasoline available for use in vehicles equipped with lead-sensitive catalyst systems. FPA's analysis shows that lead-free regulations will cost the consumer approximately $2.6 billion from 1974 to 1979. However, there will be a $2.0 billion saving between 1975-1979 due to reduced maintenance cost from the extended lifetime of exhaust components and spark plugs. This $2.0 billion figure assumes that all new cars, both catalytic and non-catalytic, and no old cars will use lead-free gasoline over the 1975-79 period. Computation is based on a 0.095 cents saving per vehicle mile using lead-free gasoline.

B. BENEFITS

1. Effects-of Mobile Source Pollutants

The effects of atmospheric pollution are pervasive, complex, and difficult to quantify in nonlaborabory situations. A number of sources and pollutants are usually involved, and there are significant problems in attempting to isolate specific cause and effect relationships. The development of more reliable techniques for relating sources to receptors is one major objective of EPA's Regional Air Pollution Study (RAPS). Mathematical models

of air pollution mechanisms, including those related to mobile source pollutants, will be developed for St. Louis, Mo. Such models will permit in-depth examination of such questions as the relative importance of mobile and stationary sources of CO, HC, and NOx. EPA is also supporting work by emissions data specialists, meteorologists, physical chemists, biologists, plant scientists, medical researchers, materials engineers, and economists in attempts to provide a quantitative analysis of the effects of mobile source pollutants and the benefits of controlling automobile emissions.

There are a number of ways of estimating the benefits of emission reductions. The most common has been to translate the physical and biological damages into economic terms. Another method is the analysis of consumer behavior in the marketplace--for example, a study of property value changes relating to levels of pollution. Opinion surveys can also indicate what people perceive as environmental stresses and what they are willing to pay to alleviate them. But assigning dollar values to the complex and far-reaching effects of air pollution is not easy even when those effects can be accurately quantified. This difficulty is particularly apparent in the case of health effects where costs are often defined in terms of reduced productivity.

A study by the California Air Resources Board is using another approach, the Delphi Method. In this application of the Delphi Method, the pooled scientific judgment of a panel of experts in the health field will enable estimation of "rough order" health dose-response relationships (damage functions) for the mobile source air pollutants for which EPA has promulgated ambient air quality standards. These damage functions can be used to estimate health benefits. Where the health benefits are in the form of fewer days lost, fewer doctor visits, or the like, the physical health benefits can be

translated into economic benefits. With this kind of information, EPA can better evaluate the tradeoffs of alternative strategies of abating mobile source emissions.

It is impossible to place an exact dollar figure on the total value of benefits to be realized by abating air pollution much less that contributed by automobiles since many market as well as extra-market effects have not been adequately quanitifed. Research continues in attempts to better specify dose-response relationships for the different receptor effects as well as to better understand the incremental impact of air pollution on human wants and behavior.

a. Health Effects

Our knowledge of the adverse effects of motor vehicle emissions is limited by a lack of systematic biological studies. However, information from epidemiological, clinical, and toxicological studies indicates that a number of health hazards are associated with motor vehicle emissions. Of the pollutants emitted by motor vehicles, the ones of principal concern to human health that are covered in this report are carbon monoxide, hydrocarbons, (as precursors of photochemical oxidants) and nitrogen oxides.

A variety of health consequences may be related to components of motor vehicle emissions (Table IV. 7). These consequences include aggravation of pre-existing disease, impairment of resistance to common respiratory infections, animal tissue changes similar to those of chronic respiratory disease in humans, and increases in body burdens. At the present time, we lack quantitative information on the significance of automotive pollutants relative to other enviromental and genetic factors that figure in the health problems of the general population.

TABLE IV. 7-ADVERSE HEALTH CONSEQUENCES
OF MOTOR VEHICLE POLLUTANTS

POLLUTANT	HEALTH CONSEQUENCES
CO	Impaired Cardiac Function Increase in Blood Carboxy Hemoglobin Levels
NOx	Acute Respiratory Defenses Chronic Respiratory Disease
OXIDANTS	Irritation of Mucous Membranes Acute Respiratory Defenses
LEAD	Increased Body Burden (Accumulation) Increased Risk of Childhood Poisoning

Carbon Monoxide.[6,7,8] Carbon Monoxide (CO) is 200 times more reactive than ambient oxygen with the blood's oxygen-carrying hemoglobin (HB). Carbon monoxide forms carboxy-hemoglobin COHb) imparing the body's oxygen-transport system (Table IV.8).

Persons with pre-existing coronary diseases (estimated as 5 percent of adults) are especially susceptible to the effects of CO. With small increases of COHb, these persons experience significant electrocardiographic changes, increased severity of angina pain and decreased tolerance to exercise.

Short-term exposure of humans to CO has also produced effects on the central nervous system. These effects may relate to problems such as impaired driving performance and resultant increases in accidents.

Photochemical Oxidants.[7,9,10] Except for limited damage to vegetation, there are few effects related to ambient concentrations of hydrocarbons. The threat of HC to human health is based on its role as a precursor of photochemical oxidants formed in polluted atmospheres containing nitrogen oxides and unsaturated hydrocarbons. The basic effects of photochemical oxidants on man involve eye mucus membrane or lung irritation, increased aging of red blood cells, visual disturbances, and impaired delivery of oxygen to tissues (Table IV.9).

The exact dose-response relationships are uncertain, but concentrations of 0.2 to 0.25 parts per million (ppm) of photochemical oxidants have consistently produced adverse health effects in man and animals. Effects are observable at lower concentrations as well. Eye irritation is associated with concentrations above 0.10ppm, and impairment of athletic performance

TABLE IV.8 - POSSIBLE ADVERSE HEALTH EFFECTS WHICH MIGHT LOGICALLY FOLLOW EXPOSURE TO CARBON MONOXIDE

EXPECTED EFFECT	RESEARCH APPROACH		
	EPIDEMIOLOGY	CLINICAL STUDIES	TOXICOLOGY
Diminished Tolerance to Exercise	No Data	Three Studies	No Data
Decreased Activity Mental	No Data	Multiple Studies	Limited Studies
Aggravation of Heart Disease	Three Studies	Multiple Studies	No Data
Increased Risk of Heart Disease	Studies of Smoking	No Data	Limited Studies
Impaired Fetal Development	Studies of Smoking	No Data	Limited Studies

Source: Finklea, John F., "Conceptual Basis for Establishing Standards", Paper in Proceedings of the Conference on Health Effects of Air Pollutants, October 3-5, 1973. Printed by Senate Committee on Public Works November 1973 (# 93-15).

TABLE IV. 9-ADVERSE HEALTH EFFECTS WHICH MIGHT BE ATTRIBUTED TO PHOTOCHEMICAL OXIDANT EXPOSURES

EXPECTED EFFECT	RESEARCH APPROACH		
	EPIDEMIOLOGY	CLINICAL STUDIES	TOXICOLOGY
Aggravation of asthma	Single study	No data	No data
Aggravation of chronic destructive lung disease	Three early studies	Two early studies	No data
Aggravation of heart disease	Three early studies	No data	No data
Aggravation of hematopoietic disease	No data	Single study	No data
Accelerated aging	No data	No data	No data
Irritation of eyes and respiratory tract in healty subjects	Multiple studies	Multiple studies	Multiple studies
Decreased cardio-pulmonary reserve in healthy subjects	Two studies	Two studies	No data
Increased susceptibility to acute respiratory disease	Single study	No data	Multiple studies
Increased risk of chronic lung disease	Single study	Single study	Two studies
Respiratory malignancies	Single study	No data	Single study
Mutagenesis, embryotoxicity, and teratogenesis	No data	No data	Two studies

Source: Finklea, John F. "Conceptual Basis for Establishing Standards", Paper in Proceedings of the Conference on Health Effects of Air Pollutants, October 3-5, 1973. Printed by Senate Committee on Public Works November 1973 (# 93-15).

has occurred at 0.12ppm. Longer term exposure to 0.13ppm increases frequency of attacks among 5 percent of asthma patients studied. The primary oxidant, ozone, in concentrations of 0.3 ppm produces nasal and throat irritation. At 0.6 to 1.0 ppm, ozone significantly impairs pulmonary function. Concentrations of 1.0 and 3.0 ppm are intolerable to some subjects; a 9.0 ppm concentration leads to severe illness.

EPA is currently engaged in community epidemiogical studies in Southern California to better understand the impact of photochemical oxidants on respiratory diseases. Other studies are examining the toxicological effects of photochemical products found in exhausts from fuels with new additives.

Nitrogen Dioxide[7,11]. The nitrogen oxide of concern is nitrogen dioxide (NO_2), which has toxic effects primarily involving the lungs (Table IV. 10). At concentrations greater than 100 ppm, NO_2 is lethal to most species. Man smells it at levels of 0.12 ppm, and short-term exposure to concentrations of 5 ppm causes a transient increase in airway resistance. Long-term exposures (6 months) to concentrations of 0.062 to 0.109 ppm brought an increased incidence of acute respiratory disease in some families. At concentrations of 0.063 to 0.083 over a 6-month span, an increased frequency of acute bronchitis was found among infants and school children. EPA is engaged in community epidemiological studies designed to define better the effects of nitrogen oxides on human health.

Other Health Studies

A program has been initiated to study the creation and content of aerosols (liquid or solid suspensions in air) produced photochemically from auto

TABLE IV.10 - ADVERSE HEALTH EFFECTS WHICH MIGHT BE ATTRIBUTED TO NITROGEN DIOXIDE

EXPECTED EFFECT	RESEARCH APPROACH		
			TOXICOLOGY
	Epidemology	Clinical Studies	At Low Exposure Levels (9000ug/m3)
Increased susceptibility to Acute Respiratory Disease	Three replicated studies	No data	Replicated rodent studies
Increased Severity of Acute Respiratory Disease	Two replicated studies	No data	Two studies with rodents
Increased Risk of Chronic Respiratory Disease	Two studies showing reduced ventilatory function in children	Anecdotal case reports	Four studies in rodents
Aggravation of Asthma	One study suggesting particulate nitrates aggravate asthma	No data	No data
Aggravation of Heart and Lung Disease	No data	No data	No data
Carcinogenesis	No data	No data	No data
Fetotoxicity or Mutagenesis	No data	No data	No data

Source: Finklea, John F., "Conceptual Basis for Establishing Standards", Paper in Proceedings of the Conference on Health Effects of Air Pollutants, October 3-5, 1973. Printed by Senate Committee on Public Works November 1973 (# 93-15).

exhaust, and to study the effect of these aerosols on animal physiology. The use of catalytic converter systems on automobiles may also increase sulfur dioxide and suspended sulfate levels in the immediate vicinity of roadways. The adverse health effects of these pollutants have been well documented.[12,13]

Use of certain catalysts may cause large numbers of very fine particles of metal compounds to be emitted into the air. However, the total amount of metal emitted into the air from automobiles should be substantially reduced when lead is removed from gasoline. Tests are being conducted in EPA laboratories to determine the general and specific toxicity of any catalyst metals entering the atmosphere.

Specific toxicity studies involve irritation of the eyes, bronchospasm induction, carcinogenesis, embryotoxicity, and resistance to respiratory infection.

b. Effects on Materials

Effects of NOx and Ozone. One of the significant materials costs attributable to ozone is that to elastomers --primarily rubber. Ozone oxidizes and thus produces cracking of rubber surfaces that are under stress. The costs attributed to preventive measures and premature failure of rubber products due to ozone is estimated at approximately $500 million annually.[14] This estimate neglects secondary costs associated with possible safety aspects such as the effects of premature parts failure on frequency of auto accidents.

NOx and ozone cause fading of textile dyes. To combat this problem, dye manufacturers have incurred the extra expense of adding antioxidant compounds to their dyes. Excessive fading results also in decreased product life. One investigator has estimated that costs of avoiding

dye-fading amount to approximately $200 million annually.[15/]

Total Materials Costs. Recent estimates for the year 1970 place the total materials costs associated with air pollution in the range of $1.3 to $3.1 billion, with a "best" estimate of $2.2 billion. Of this $2.2 billion, $0.7 billion is associated with the complex of air pollutants identified as oxidants. Ozone and NOx, the primary auto-related pollutants that affect materials, are assumed to be major components of the oxidants category.[16/]

No effects of CO and HC on materials have been recorded. It is not known to what extent auto sulfate emissions will impact on general atmospheric sulfate levels, nor what impact these levels will have on general deterioration of materials. Also, it is not known to what extent NOx plays a role in the corrosion of metals, or what effects ozone and NOx have on other processes that deteriorate statuary and other works of art.

Current Studies. Data from laboratory experiments in controlled environments are being analyzed to determine the direct and synergistic effects of ozone and NO with SO and relative humidity on a variety of economically important materials.

c. Effects of Vegetation

Hydrocarbons. Among the many hydrocarbons emitted by motor vehicles, ethylene causes significant damage to vegetation. Concentrations ranging from 0.001 to 0.6 ppm ethylene for 8 to 24 hours can cause significant effects on plant growth, yield, flower and leaf retention, and leaf orientation. Ethylene concentrations of 0.001 ppm

for 20 hours cause blight on African marigolds. The flowers of orchids, snapdragons, and carnations have been damaged at concentrations between 0.01 and 0.5 ppm. Flower buds of tomato and pepper plants have dropped at 0.1 ppm within 8 hours. Economic losses have caused many commercial flower growers to relocate to areas free of excessive ethylene pollution. In spite of these significant direct effects, the major problem with ethylene and other hydrcarbons is their contribution to the formation of photochemical oxidants.

Nitrogen Dioxide. The exposure of many plant species to more than 1 ppm NO_2 for one or two days will result in necrotic leaf lesions. These lesions can be associated with reduced growth which detract from the value of crops such as radish and spinach where external appearance is important. Exposures of plants to more common ambient levels of 0.25 to 0.4 ppm NO_2throughout the growing season, reduced crop yield tomatoes by 22 percent. Cropyields of naval oranges have also been reduced. Recent reports show that concentrations of NO_2 and SO_2 mixtures containing from 0.1 to 0.25 ppm of both acted synergistically in reducing photosynthesis. Like hydrocarbons, NO_2 and other oxides of nitrogen are most significantly linked to the formation of photochemical oxidants.

Photochemical Oxidants. Photochemical precursors and associated levels of atmospheric oxidants originate in urban and industrial areas, but they can be dispersed and expose vast rural areas.

While measurable success has been made in associating plant damage to photochemical oxidantε, it is still difficult to separate the affects of individual pollutants. In terms of occurrence and damage to vegetation, ozone and peroxyacetylnitrate (PAN) are the most important photochemical oxidants. PAN has been identified as a problem in the Los Angeles Basin of Southern California and other metropolitan areas.

A recent study by the Stanford Research Institute estimates that direct oxidant damage to commercial crops and ornamental plants amounts to about $120 million. The total value of plant destruction, resulting from automotive sources alone, is between $36 million and $72 million.[17/]

Controlled laboratory exposures have demonstrated that most sensitive plant species respond to oxidant concentrations as low as 0.05 ppm. (Natural background levels of ozone have been calculated at 0 to 0.03 ppm.) Both exposure duration and pollutant concentration are important variables in determining the type and magnitude of plant response to photochemical oxidants. Generally, plant reponse can be categorized as chronic or acute. Acute plant responses result from relatively high oxidant concentrations and short exposure periods, resulting in rather distinct foliar injury. In contrast, chronic responses are generally nondistinct chlorotic or pigmented changes in foliage resulting from relatively low oxidant concentrations and long exposure periods.

Current Studies and Programs. Greenhouse and laboratory studies are being conducted to define the dose-response relationships for gas mixtures (O_3 and SO_2 ; NO_2 and SO_2) including the influence of natural environmental conditions on the response of plants to these gas mixtures. Efforts are underway to standardize the methodology of plant assessment, which requires correlation of foliar injury with reduced growth and yield. The effects of ozone on plant quality components such as protein, amino acids, and carbohydrates are being studied and the relation is being determined between these quality components and plant vigor. The alteration of basic physiological processes in test plants exposed to chronic low levels of ozone can be monitored. Preliminary results indicate that ozone reduces levels of carbohydrates and leads to accumulations of toxic phenol metabolites reflecting adversely on yield and quality of crops.

A 5-year field ecosystems study is currently in progress in the San Bernardino Forest of Southern California to identify the response of a mixed conifer forest ecosystem to ambient levels of photochemical oxidants resulting from automobile emissions in the Los Angeles basin.

d. Other Aspects of Controlling Mobile Source Emissions

Aesthetic Effects of NO_2 and Oxidants. Research has shown that NO_2, and particulate aerosols including lead particles can cause the visibility reducing brown haze that characterizes many metropolitan areas. Some have reasoned that reduced visibility results in aesthetic losses and psychic costs and, in general, contribute to a degradation in the urban environment and quality of life.

Social Aspects. People living in the inner city, where CO, NOx, and oxidant levels are typically high, may be particularly susceptible to adverse health effects because of age or inadequate health care.

Effect of Vehicle-Free Zones on Downtown Areas. Partial bans on central business district traffic have been attempted in many European and some American cities. In addition to reducing noise and pedestrian inconvenience, the bans caused a drastic drop in carbon monoxide air pollution levels. CO levels in New York's Madison Avenue dropped from 30 to 5 ppm with the traffic ban. Merchants and shoppers have reacted favorably to traffic bans, but the relative effects of noise abatement, decreased pedestrian inconvenience, and reductions in air pollution are impossible to isolate. Vienna, Austria, is creating a large environmental oasis in its downtown section, and it is clear that air pollution abatement will be one of its attractions.

2. Improvement of Air Quality

Availability of data limits analysis of trends for CO to Los Angeles, California, and Newark, New Jersey. In Los Angeles, trends of ambient CO concentrations are predominantly downward. The greatest improvement has been in reduction of the annual percentage of excursions above the eight hour average. Evidence of this reduction in downtown Los Angeles is demonstrated by a decrease in the 1 hour maximum concentration from 48 mgm/m^3 in 1963 to 39 mgm/m^3 in 1972.

Ambient Air Quality data are available from certain other cities during the fuel shortage of 1973-1974. Analysis of this data indicates that ambient CO levels decreased in New York City, N. Y., Portland, Ore., and Richmond, Va., but increased in Mamaroneck, N. Y., Providence, R. I., and Boston, Mass.

The higher readings in Mamaroneck are suspect, since the sampler was located adjacent to a road where motor vehicle operators idled their engines while waiting for gasoline pump service.

Data for analysis of trends of oxidant concentrations are available only from Los Angeles and Newark. In Los Angeles, the general trend has been downward since the late 1960's. In downtown Los Angeles, the 1-hour oxidant standard was exceeded 921 times in 1963 and 516 times in 1972. In Newark, the maximum 1-hour oxidant concentration was reduced from 411 ugm/m^3 in 1969 to 200 ugm/m^3 in 1972. The extent of the decline is more apparent in the number of times the national oxidant standard was exceeded. In 1969, the standard was exceeded in 50 out of 6,963 readings (0.7 percent) while in 1972 only 16 of 7,756 readings (0.2 percent) exceeded standards.

Buslanes are being tried in several urban areas to reduce vehicle miles traveled. DOCUMERICA- Yoichi Okamoto

CHAPTER V. RELATED EPA PROGRAMS

A. Certification Program for New Motor Vehicles

1. Certification Determination

Certification of new passenger cars for compliance with Federal emission standards began with the 1968 model year. The program includes testing of prototype vehicles that represent all new motor vehicles sold in the United States. The manufacturer is required to submit data showing that prototypes conform to Federal exhaust, crankcase and fuel evaporative emission standards.

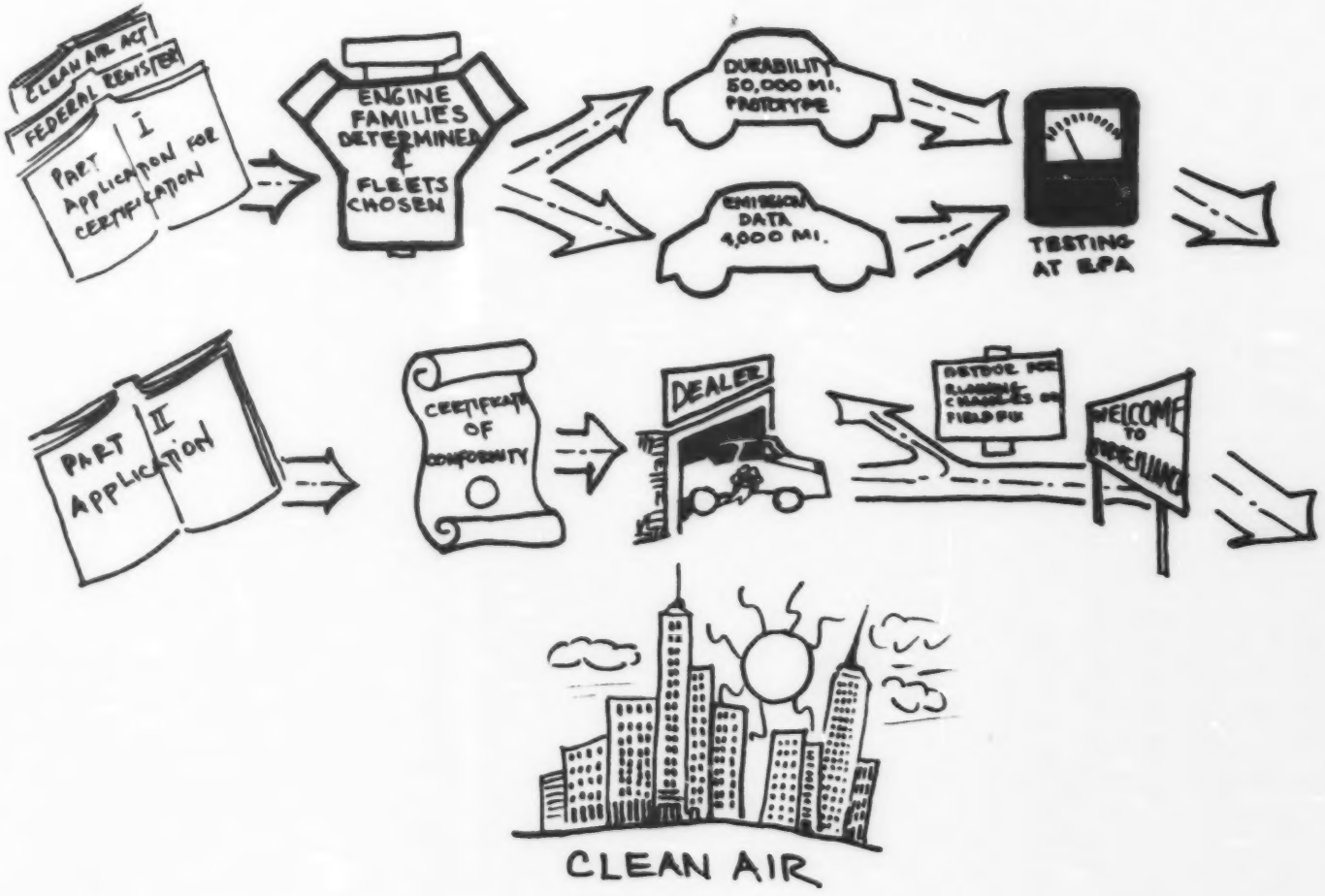
The certification process begins when the manufacturer submits an application to participate in the program. This is a Part I Application (Figure V.1) and its purpose is to:

- o give notice to EPA of the manufacturer's intent to sell vehicles.
- o provide information to determine whether the test equipment, test fuel, and mileage accumulation procedure proposed by the manufacturer conforms to the regulations.
- o provide necessary description of the proposed product line including projected sales data which allows EPA to select the test fleets.

There are two different test fleets: an emission data fleet and a durability data fleet. The emission data fleet consists of a number of vehicles tested at 4,000 miles to establish the emission level of a vehicle close to its "break-in" point. The durability fleet consists of a smaller number of vehicles tested at 4,000 mile intervals to 48,000 miles and at 50,000 to determine the deterioration of the vehicles' emission control systems.

Figure V.I

Certification Process



The vehicle selection process starts by dividing the manufacturer's product line into groupings of vehicles called "engine families". The engine family is the fundamental unit in the certification process in that ultimate compliance is determined on an engine family basis. Once the product line is divided into engine families, up to eight emission data vehicles are chosen to represent each engine family. Selection of durability data vehicles for each engine family is on an "engine-system combination" basis. An "engine-system combination" is a unique combination of engine family, exhaust emission control system and evaporative emission control system.

After the manufacturer receives notification that his proposed procedures and equipment are acceptable and has been notified of the required test fleets, mileage accumulation and emission testing at the manufacturer's facility can be initiated. At any test point, EPA can require that the vehicle be brought to the EPA laboratory in Ann Arbor, Michigan, to confirm the manufacturers testing results. Currently, confirmatory tests are routinely required for all emission data vehicles at the 4,000 mile test point, and for most durability vehicles at the 50,000 mile test point (some durability vehicles are tested at intermediate mileage points).

After completion of all tests on all emission data and durability data vehicles in an engine family, the manufacturer submits a request for issuance of a Certificate of Conformity (called a Part II Application). The request contains a compilation of all test data and a full description of all maintenance performed. Based on the durability vehicle test data, a deterioration factor (ratio of exhaust emissions at 50,000 miles to the exhaust emissions at 4,000 miles) is established for each exhaust pollutant for each engine-system combination. The exhaust emission test

results of each emission data vehicle in the engine family are then multiplied by the appropriate deterioration factors. If the emissions of every emission data vehicle in the engine family, as adjusted by the appropriate deterioration factors, meet all the applicable standards, the manufacturer is issed a certificate of conformity for that engine family. The certificate is effective for one year, or until the end of the model year; whichever comes first. If any of the vehicles do not meet applicable standards, the manufacturer is so notified. If he does not request a hearing within 30 days or if the hearing affirms the finding of nonconformity, the manufacturer has two options:
The first alternative is to delete from the application for certification the vehicles represented by the failing test vehicle. Then EPA may select in place of the failing vehicle an alternate vehicle chosen in accordance with the selection criteria employed in selecting the vehicle that failed. The second alternative is to modify the test vehicle and demonstrate by testing that it meets applicable standards. Another vehicle identical to the first vehicle, as modified, must then be operated in accordance with applicable test procedures. If the manufacturer fails to follow either alternative, certification of the affected engine family is denied.

During the past year, certification of 1974 model year light-duty vehicles and heavy-duty engines was completed, and certification of 1975 models is now well underway. The certification program for the 1975 model year involves monitoring the test programs of approximately 60 manufacturers and reviewing durability data from approximately 450 vehicles and engines and emission data from 650 vehicles and engines. This effort represents about a 100 percent increase in durability vehicles and a 40 percent increase in emission data vehicles over the previous model year and requires that EPA conduct approxi-

imately 2,500 planned emission tests. This increase is primarily a result of the creation of a separate set of Federal emission standards for California.

As a result of the unauthorized and unreported maintenance practices by Ford Motor Company concerning 1973 certification vehicles, EPA has expanded its certification program to increase surveillance of domestic manufacturers' testing programs, to perform periodic inspection of manufacturers' facilities and records, and to investigate reports of possible violations of regulations.

Several trips each week are made to domestic manufacturers to observe scheduled and unscheduled maintenance and mileage accumulation, and to insure that established test procedures are followed. In-depth inspections of major manufacturers' programs are made annually.

In addition to the requirements for certification of motor vehicles prior to mass production, EPA has regulations governing changes to vehicles during mass production and introduction of new models. Approximately 800 requests for such changes during this past year were reviewed and more than 200 tests were conducted to determine compliance with standards.

Certificates of conformity are also issued to cover heavy-duty gasoline and diesel engines. This year, EPA monitored the test programs of approximately 15 manufacturers and, following the completion of emission testing, issued approximately 100 certificates of conformity with emission standards. In addition, over 200 requests were processed to make changes during mass production and to introduce new engines.

Since the 1971 model year, emission test results have been published in the Federal Register. Beginning with the 1973 model year, the fuel consumption during the emission test has also been determined and published

in the Federal Register as well as in a booklet for consumer use. (Table V.11). Fuel economy information was also presented by participating manufacturers to car buyers in a format as presented in Table V.1. The driving cycle used in that emission test is representative of typical city driving common to urban commuting. To provide the consumer with additional fuel economy information, a highway fuel economy test procedure was developed early this yeaar and is being used to test 1975 model year vehicles. Thus, emission test results and a broad picture of fuel economy tests results will be available to consumers increasingly concerned with both air quality and conservation of natural resources.

2. Inspections/Investigation Program

EPA conducts periodic, scheduled audits of vehicle manufacturer certification procedures and inspections of facilities to ensure that certification procedures are being observed. In the past year, EPA has conducted 24 of these in-depth vehicle manufacturer inspections. EPA's inspection team inspected 12 foreign manufacturers and 12 domestic manufacturers.

During the past year, EPA also initiated 17 investigations of potential manufacturer violations of the Clean Air Act and made three referrals to the Justice Department. A complaint against Volkswagen AG and Volkswagen of America for the existence of unreported defeat devices on certain 1973 Volkswagens was settled by stipulation in the amount of $120,000.

3. Exclusion and Exemption Program

EPA may individually exclude certain types of vehicles from being subject to the Clean Air Act if it meets one of the following criteria:

TABLE V.1

GAS MILEAGE FOR 1974 AUTOMOBILES (a)

VEHICLE TEST WEIGHT (lbs.)	RANGE (miles/gallon)	AVERAGE (miles/gallon)
2,000	22 - 29	24
2,250	19 - 25	21.5
2,500	17 - 22.5	18.5
2,750	10.5 - 24.5	17.5
3,000	9 - 20	15
3,500	10.5 - 20	13.5
4,000	6.5 - 19	10.5
4,500	7.5 - 14	9.5
5,000	7 - 11	9
5,500	7 - 10.5	8

NOTE:

(a) Using a test procedure which simulates commuter-type driving. Results are not indicative of high-way-type driving.

- o Inability to maintain a maximum speed fo 20 miles per hour.

- o Lack of certain features customarily associated with safe and practical highway use, such as reverse gear, differential, or safety features required by State of Federal law.

- o Possession of certain features that render its use on the street or highway unsafe, impractical, or highly unlikely, such as tracks, an inordinate size, or features ordinarily associated with military combat or tactical vehicles.

EPA grants 3 types of exemptions from emission standards to manufacturers for both new and in-use vehicles and engines:

- o Tesing Exemptions - given if the manufacturer indicates a valid test purpose, a reasonable scope, a necessity for the exemption and a significant degree of control over the exempt vehicles or engines.

- o National security exemptions - granted of endorsed by a Federal agency charged with national defense.

- o Export exemptions - given automatically without request for vehicles or engines intended solely for export to a country with emission standards not identical to EPA standards; vehicles or engines must be labelled accordingly.

B. SELECTIVE ENFORCEMENT AUDITING PROGRAM FOR PRODUCTION VEHICLES

Selective Enforcement Auditing is a program in which EPA will test new motor vehicles or new motor vehicle engines being manufactured in actual assembly line production. The purpose of the program is to determine whether assembly line vehicles or engines do in fact conform with regulations with respect to which the certificate of conformity was issued.

The procedure EPA follows is to issue an administrative order to the manufacturers to select certain production vehicles for testing. If EPA finds that the test results do not conform with the regulations under which the Certificate of Conformity was issued, EPA may revoke the

Certificate.

C. ENFORCEMENT OF VEHICLES IN USE AND FUEL STANDARDS

EPA, in addition to ensuring that new vehicles meet Federal Emission Standards, also directs enforcement efforts at ensuring that vehicles continue to meet standards throughout their useful lives. EPA is also responsible for enforcing fuel regulations and availability of regulated fuels.

EPA is encouraging states to assume a greater role in various mobile Source Enforcement activities. Primary emphasis is being directed at the tampering, TCP's and fuels areas.

1. Anti-Tampering Program

Section 203(a)(3) of the Clean Air Act prohibits any manufacturer or dealer knowingly to remove or render inoperative a vehicle's emission control system after sale of the vehicle to the ultimate purchaser. During the past year, 20 investigations of potential violations of the tampering prohibitions of the Clean Air Act have been conducted. Five cases were referred to the Justice Department for action resulting in prosecution of one dealership for removal of emission control systems; a $500 fine was secured. EPA is conducting surveys to determine whether tampering is a significant problem in the Nation. Conducted by State motor vehicle departments, these surveys consist of a visual check of the emission control systems of 2,000 vehicles as they pass through annual inspection. The Washington, D. C. survey, revealed that major components of the emission control system had been removed in 15 percent of the vehicles inspected.

The most effective enforcement against tampering lies at the State level. EPA is encouraging States to establish anti-tampering programs as part

of their inspection/maintenance plans. Several States have adopted anti-tampering prohibitions which apply to everyone after sale of the vehicle, rather than just dealers and manufacturers. EPA is conducting a survey to determine exactly which States do have anti-tampering prohibitions. To aid in the effective enforcement of antitampering laws, EPA has printed an inspector's guidebook depicting all emission control systems of 1973 foreign and domestic vehicles.

2. Recall Program

Section 207(c) of the Clean air Act requires the EPA Administrator to notify a manufacturer to recall and repair vehicles of a given type when the Administrator determines that a substantial number of them do not conform to applicable emission standards during their useful lives. The objective is to provide incentives to manufacturers to build vehicles in all material respects like the prototype vehicle used for Certificate of Conformity testing. The Recall program consists of surveillance and investigation, recall order implementation and public reporting.

Surveillance presently consists of the in-use compliance program, defects reporting from government and commercial fleets, obtaining data from State and local inspection/maintenance centers, emission test results and consumer and other complaints. The in-use compliance program was initiated with the 1972 model year, the first year for which Section 207(c) was applicable. EPA tested emissions of 24 engine classes [18/] of 1972 model year vehicles. In aggregate the 24 represented about 70 percent of all 1972 vehicles sold in the United States. Test vehicles were selected statistically to assure the sample accurately represented each of the engine classes. Additionally, vehicles showing any sign of abuse or

abnormal operation were rejected, and all test vehicles were put into an optimum state of tune-up prior to testing. On the basis of these results, EPA announced on June 25, 1974 that four major automobile manufacturers had been notified that some of their 1972 model year vehicles appeared to be in violation of Federal air pollution emission standards. As many as 1.4 million automobiles may be involved and thus subject to recall. The companies were given ten days from the June 25 notice date to provide additional information they might have relevant to emission performance of the vehicles involved. After consideration of this additional information, EPA will decide whether to issue recall orders to these manufacturers.

In a second series of surveillance tests begun early this year, 1973 model year vehicles (100 from each of 31 engine classes) are being evaluated. Vehicles for these tests were again selected statistically. The testing under this program is being conducted in various U. S. locations and is expected to be completed in early 1975.

Currently, 12 other investigations are in progress. One earlier investigation yielded a major EPA recall. Chrysler Corporation vas required to correct a defect in the emission control system designed to reduce nitrogen oxide emissions; 825,000 cars and 1,000 1974 trucks were involved. Of this recall, 30 percent have been remedied. Regulatons were proposed March 25, 1974 to establish procedures for implementation of recall orders. These regulations contain requirements for remedial plan contents, recall campaign reporting, and hearing procedures.

Public reporting involves the plan to publish periodic information on recall activities. EPA expects to publish the first report early in 1975.

3. Warranties Program

Section 207(a) of the Clean Air Act provides for a defects warranty starting with the 1972 model year. EPA has concluded that consumers do not understand what is covered by this warranty, which is contained in all owner's manuals, and therefore, few claims are being made under it. To overcome this difficulty, EPA intends to publish--or require the vehicle manufacturers to publish--lists of those defects covered by 207(a). Defects on this list would be presumed to cause emission standards to be exceeded. EPA also intends to institute a program to monitor the vehicle manufacturer's effort under the warranty.

The 207(b) performance warranty of the Clear air Act cannot be implemented until EPA develops a short test which reasonably correlates with the sophisticated Federal test procedure used on prototypes of new vehicles. Technical problems centering on achieving satisfactory correlation for future model year vehicles have delayed implementation of this provision. However, EPA is making a renewed effort to develop a short test, with the 1976 model year as a target date. After a short test is developed, EPA will encourage States to select this short test for inspection-maintenance programs as a part of their transportation control plans that they prepare under Section 110 of the Act.

4. Aftermarket Parts Program

EPA intends to pursue a program of voluntary self-certification for manufacturers of certain categories of automotive aftermarket parts. "Aftermarket parts" are those parts which are not "original equipment," that is, they are not produced by or for the vehicle or engine manufacturer. The aftermarket parts program will attempt to identify the parts and components important to emissions performance and develop standards for

such parts. This will enable aftermarket parts manufacturers to have the option of designing and building their parts in conformity with the standards and advertise them as being on a par with the original equipment they replace. The program is intended to help alleviate any potentially adverse competitive impact of the emission control warranty by providing an objective basis for ensuring that aftermarket parts do not d grade emissions performance. EPA will support industry effort to develop acceptable test procedures and the program will be announced in the Federal Register.

5. Imports Program

In conjunction with the U. S. Customs Service, EPA monitors imported vehicles to ensure that they conform with U. S. emission standards. Those not conforming may be imported under a U. S. Customs bond pending modification of the vehicle to meet U.S. emission standards. Vehicles that cannot be modified to conform must be exported or destroyed.

EPA periodically visits Customs ports in the United States to inspect imported vehicles, and to meet with customs offic.als concerning enforcement of the joint EPA-Customs regulations. During the past year, EPA made visits to 32 various ports of entry in the United States. EPA monitored approximately 3 million commercial and privately-owned vehicles, issued 250 notices to modify noncomplying vehicles, and issued 75 administrative orders to export vehicles that could not be brought into conformity.

EPA also initiated 26 investigations of potential violations of the import provisions of the Act. One of these investigations resulted in a prosecution of one dealership for illegally importing 14 motor vehicles into the U. S. The corporation was assessed a civil penalty of $25,000 and a criminal penalty of $30,000 (reduced to $4,500).

6. Fuels Program

EPA has established a field sampling inspection system to assure the general availability of lead-free fuel at the retail outlet. Each Region will inspect approximately 2,000 retail outlets per year. Each of EPA's 10 Regional offices will have a mobile fuels test laboratory and two personnel (one fuels inspector and one legal, administrative and laboratory back-up). The fuel inspector will sample and test lead-free gasoline at the retail outlets to ensure that the gasoline meets standards for lead-free fuels. Fuels inspectors will perform on-site field tests and issue notices of contamination to any retail outlet having contaminated gasoline. All tests indicating contaminated gasolines will be sent to the laboratory for confirmation. In addition, EPA will send approximately 10% of all field samples meeting standards to the laboratory for confirmation.

EPA is currently developing a quality control program to monitor the results of the Regional program.

With regard to fuels enforcement, state departments such as the Department of Weights and Measures are being encouraged to conduct lead-free gasoline sampling. States are also being encouraged to adopt lead-free gasoline regulations identical to EPA, although EPA has no authority to require the states to do either. Experience to date indicates that States are reluctant to adopt lead-free gasoline regulations identical to EPA unless EPA provides these states with substantial financial assistance either in the form of state grants or personnel.

D. OTHER EMISSIONS INVENTORY PROGRAMS

1. Light-Duty Vehicles

As often as practical, EPA develops current data on emissions of in-use light-duty vehicles so that State and local agencies, Federal Air pollution officials, automobile manufacturers, and concerned citizens can estimate the impact of emissions from light-duty vehicles on air quality. Under EPA contract 1,020 1966 through 1972 model year light-duty vehicles were tested. The testing, conducted in Los Angeles, Calif., Denver, Colo., Houston, Texas, St. Louis, Mo., Chicago, Ill., and Washington, D. C., involved both hot and cold engine starts. In addition, total evaporative emissions were determined using an improved technique whereby vehicles were placed in a sealed enclosure.

Contractors to EPA are now working on a follow-up study to determine exhaust and evaporative emission factors for 1967 through 1974 model year light-duty vehicles. Final reports are due in the next few months.

A report entitled "Automobile Exhaust Emission Modal Analysis Model" has been completed for EPA. This report describes a mathematcal model and allied computer programs for calculating the emissionsof groups of vehicles over any specified driving sequence which will be used in air quality impact analysis.

2. Heavy-Duty Vehicles

Contractors are also monitoring exhaust emissions from heavy-duty gasoline-powered vehicles to compare emissions from 1970 and 1971 in-servicevehicles with the applicable Federal standards. This work involves emulating the 1970 Federal test procedure through use of a chassis dynamometer. To produce emission data more directly useful for air qualityimpact estimates, test results will be expressed in terms of

weight of the pollutants emitted per vehicle mile (i.e., gram per mile) in addition to concentration of the pollutants of the tail pipe (e.g., parts per million) by which the 1970-73 standards were expressed.

Another contract has been completed covering emission surveillance of heavy-duty vehicles powered by diesel engines. The purpose was to determine the effectiveness of the Federal exhaust smoke regulation on heavy-duty diesel-powered vehicles operating in the Southwestern United States. A fleet of 64 test vehicles, representative of the vehicle population, was used.

At present, contracts are underway to measure exhaust emissions from diesel-powered and precontrolled gasoline-powered vehicles during actual operation over a road route. This will supplement the work completed on controlled gasoline-powered trucks.

E. SUPPORTING EMISSIONS CHARACTERIZATION PROGRAM

1. Emissions at Nonstandard Temperatures

Ambient temperatures outside the 68° to 86° F ranges specified in the Federal procedure for emission testing of light-duty vehicles were studied in a program conducted by the U. S. Bureau of Mines. The vehicles tested included precontrol (1967) models, production cars from model years 1969 through 1974, several developmental cars equipped with advanced emission control systems (including catalytic converters), and a diesel and a stratified charge powered car. The test temperature ranged from 20° to 110° F. Cars equipped with air conditioners were also tested at 110° F with the air conditioner in operation. The tests show that exhaust emissions are adversely affected by deviations from the standard test temperature of 75° F and by air conditioner operation. Fuel economy is adversely affected by temperatures lower that 75° F and by air conditioner

operation. Emissions of hydrocarbons and carbon monoxide are more sensitive to ambient temperature changes than emissions of nitrogen oxides. In general, as the absolute level of emissions in the newer and developmental cars drops, the sensitivity to change in temperature becomes greater. Of all 26 cars tested, the diesel and stratified charge cars are lowest in emissions, highest in fuel economy, and least sensitive to ambient temperature.

2. Currently Unregulated Emissions

In prior years, studies on unregulated emissions from motor vehicles have concentrated on characterization of reactive hydrocarbons, aldehydes, polycyclic organic matter (POM) and particulate emissions. More recently, other unregulated pollutants have been identified and are being thoroughly investigated by EPA. These new compounds include sulfates, platinum and other noble metal emission from catalysts, and miscellaneous compounds such as nickel, hydrogen sulfide and others.

EPA's Office of Research and Development has recommended classifying all hydrocarbons as reactive except for five compounds (one of which is methane) which are generally considered totally non-reactive photochemically. Instrumentation for measuring reactive hydrocarbons has been developed at EPA's National Environmental Research Center in Research Triangle Park, North Carolina. The Motor Vehicle Emissions Laboratory in Ann Arbor is setting up this instrumentation to measure reactive hydrocarbons by this reactivity scale. However, EPA is also investigating the feasibility of having a non-methane emission standard, which would be inherently simpler than the reactivity approach. Thus, lower priority has been given this area of investigation.

While aldehyde compounds are a distinct chemical class from hydro-

carbons, they are considered in conjunction with reactive hydrocarbons since both are photochemically reactive. Routine measurement of aldehyde emissions is conducted on advance prototype vehicles sent to EPA for testing. Although isolated points show high aldehyde levels, this work continues to show that aldehydes generally amount to only about 10 percent of the total hydrocarbon emissions.

Since previous work showed that properly functioning advanced light-duty vehicles (including those equipped with catalytic converters) emit insignificantly small amounts of POM, little has been done in this area the past year. However, investigations of POM emissions from light and heavy-duty diesel vehicles are currently being conducted.

Under EPA contract, higher particulate emissions from catalyst-equipped vehicles were measured in 1972. During this work, the contractor discovered that these cars also emit higher levels of sulfates. EPA then began intensive research in the sulfate area. Contract work was recently completed to measure total particulate emissions from advanced prototype vehicles. Also, EPA has acquired the in-house ability to measure particulate emissions from light-duty vehicles. The total level and composition of these emissions are being assessed.

3. Sulfate Emissions

Since the discovery of sulfate emissions, more extensive characterization of sulfate emissions has been done by various groups, including EPA's Office of Mobile Source Air Pollution Control and Office of Research and Development.

EPA has measured sulfate emissions on a number of different catalyst, noncatalyst, and alternative engine automobiles. Measurements were made by a variety of methods under various steady state cruise condi-

tions and on the LA-4 driving cycle used in certifying light-duty vehicles. The lack of a standard measurement procedure has hindered the comparison of data and to some extent, impeded further research.

Results to date on the sulfate question point to the following conclusions:

- o Noncatalyst cars with conventional internal combustion engines emit very low levels of sulfates. Data from EPA-ORD, GM, Ford, and Exxon show sulfate emissions to be about 0.001 grams per mile or less than 1 percent of the fuel sulfur with the remainder being SO_2. Chrysler data indicates that sulfate emissions from noncatalyst cars are lower for leaded than non-leaded fuel.

- o Catalyst-equipped cars emit more sulfates than non-catalyst cars.

- o Pelleted catalysts emit substantially lower levels of sulfates than monolith catalysts in the EPA Test Procedure. At higher speeds, the emission levels of the two types of catalysts appear to be similar. The difference may be due to sulfate storage on the pellated catalysts at low speeds.

This information further details the conclusions presented to the Senate Public Works Committee Nov. 6, 1973. These conclusions, however, are still tentative. EPA plans to obtain additional characterization data, develop more reliable measurement methods and assess the technology for control of sulfate emissions.

F. Transportation Control Plans

The Clean Air Act requires States to prepare and submit to EPA State Implementation Plans for implementing the National Ambient Air Quality Standards (NAAQS) in each Air Quality Control Region. Transportation Control Plans must be included in State Implementation Plans when both stationary source emission controls and the Federal new car emission controls cannot attain the NAAQS (Table V.2). Some States prepared plans that were totally or partially approved by EPA. In cases

where the State did not prepare an approvable plan, EPA promulgated the Transportation Control Plan.

States have responsibility to develop and enforce TCP's and EPA is encouraging States to assume a greater degree or enforcement. Experience to date, however, indicates that no State intends to enforce all of its TCP measures and Federal responsibility for enforcement is anticipated to be substantial in FY 1976.

1. Transportation Control Plan Measures

Carbon monoxide and hydrocarbon levels are to be reduced through the implementation of Transportation Control Plans incorporating a combination of the following measures: additional stationary source controls, reduction in vehicle miles travelled, inspection and maintenance, mechanical retrofit, and gasoline supply restrictions.

a. Additional Stationary Source Controls

Additional controls will be imposed on a variety of stationary sources to reduce hydrocarbon emissions. These measures are not transportation control measures as such, but they are measures by the State and EPA to help reduce the hydrocarbon levels required in the Transportation Control Plans. The measures include: vapor recovery at service stations, conditions for loading and unloading barges, conditions for solvent and degreasing operations, conditions for architectural coating operations, and controlling emissions at dry cleaning establishments.

TABLE V.2

STATES WITH TRANSPORTATION CONTROL PLANS[a]

Air Quality Control Region or (Portion)	Control Measures[b]
Alaska	
Fairbanks	VMT, I/M, Air Bleed, Catalyst
Arizona	
Phoenix-Tucson	VMT, I/M, Air Bleed, Catalyst, EGR
California	
Los Angeles	VMT, I/M, VSAD, Catalyst Service Station, Additional Stationary Control
Sacramento	VMT, I/M, VSAD, Catalyst, Service Station, Additional Sationary Control
San Diego	VMT, I/M, VSAD, Catalyst, Service Station, Additional Stationary Control
San Francisco	VMT, I/M, VSAD, Catalyst Additional Stationary Control
San Joaquin Valley	VMT, I/M, VSAD, Catalyst, Service Station, Additional Stationary Control
Southeast Desert[c]	
Colorado	
Denver[d]	VMT, I/M, Air Bleed, High Alt. Mod., Service Station
National Capital	
Washington, D.C. and parts of (Md. & Va.)	VMT, I/M, VSAD, Catalyst, Air Bleed, Air Craft Control Program

STATES WITH TRANSPORTATION CONTROL PLANS - CONT'D

Illinois	
Chicago	VMT, I/M
Indiana	
Indnanapolis	I/M, Service Station
Maryland	
Baltimore	VMT, I/M, VSAD, Air Fuel, Catalyst, Service Station, Gasolina Limitations
Massacusetts	
Boston	VMT, I/M, VSAD Air Bleed, Catalyst, Service Station
Springfield	VMT, I/M
Minnesota	
Minneapolis-St. Paul	VMT
New Jersey	
Trenton-Camden [e]	VMT, I/M, E.G.R., Catalyst, Service Station, Additional Stationary Controls
Newark [f]	VMT, I/M, E.G.R., Catalyst, Service Station, Additional Stationary Controls
New York	
Metro-New York City	VMT, I/M, Heavy Duty Truck Retrofit [g], Taxi Controls
Rochester	I/M

STATES WITH TRANSPORTATION CONTROL PLANS - CONT'D

Ohio	
Cincinnati	I/M
Oregon	
Portland	VMT, I/M, Air Bleed
Pennsylvania	
Philadelphia	VMT, I/M, Air Bleed, Service Station
Pittsburgh	Being revised per court order
Texas	
Austin-Waco	VMT
Corpus Christi	VMT
Dallas-Ft. Worth	VMT, Service Station
El Paso	VMT, Service Station
Houston-Galveston	VMT, VSAD, Service Station, "Ship & Barge loading/unloading facilities vapor control"
San Antonio	VMT, I/M, Service Station
Utah	
Wasatch Front	VMT (Salt Lake City), I/M, VSAD
Salt Lake City	High Alt. Mod. (d)
Provo	
Odgen	
Washington	
Seattle	VMT, I/M, Air Bleed, E.G.R.
Spokane	VMT, I/M, Air Bleed, E.G.R.

FOOTNOTES TO TABLE V-2

(a) Certain states examined data and redid their emission inventory. They determined that standards could be achieved without transportation control plans. The cities include: Baton Rouge, La., Birmingham, Ala., Mobile, Ala., Syracuse, New York., Kansas City, Kansas, Toledo, Ohio.

(b) "VMT" - Measures to reduce vehicles miles traveled
"Service Station" Gasoline vapor control at service stations
"I/M" - Inspection and maintenance of motor vehicles
"VSAD" - Vacuum spark advance disconnect retrofit
"Catalyst" - Catalyst retrofit
"Air Bleed" - Air Bleed retrofit
"High Alt. Mod." - High Altitude Modification
"EGR" - Exhaust Gas Recirculation retrofit
"Air Fuel" - Air Fuel Control retrofit

(c) No plan yet becasue major source of pollution is Los Angeles (F.R. Nov. 12, 1973)

(d) The High Altitude Modification tests have not been satisfactory. Tests of a form of EGR/Air Bleed are promising and it may be substituted.

(e) Trenton-Camden is part of the Metropolitan Philadelphia Interstate AQCR.

(f) Newark is part of the New Jersey-New York-Connecticut Interstate Air Quality Control Region.

(g) Taxi cabs beginning with model year 1975 will have to meet the 1975 model year standards for California. This is the so called "California Package."

b. Reduction in Vehicle Miles Travelled

Several different activities aim to reduce vehicle miles travelled.

Parking Regulations include both parking management programs (off-street parking facilities) and on-street parking limitations. These activities aim to discourage the use of automobiles, primarily in the urban centers. Restrictions in the central business district can significantly reduce the carbon monoxide level, and on-street parking regulations can decrease congestion and reduce emissions due to improved traffic flows.

Section 510 of the Agriculture-Environmental and Consumer Protection Bill probibits EPA from using FY 1975 funds to -- "administer any program to tax, limit or otherwise regulate parking facilities".

Regulatory fees or surcharges for mass transit augmentation were initially promulgated, but subsequently revoked by Amendments of the Clean Air Act. These amendments authorized EPA to approve fees or surcharges only if submitted by the States.

Computerized carpool matching measures promulgated by EPA provide for formation of carpools, and preferential treatment programs provide incentives (such as free parking for carpooling groups) to encourage these carpools. Under measures included in some plans, disincentives (such as parking space reduction) are included to discourage single occupancy of automobiles during commuter trips.

Bus priority treatment consists of allocating highway facilities in a preferential manner to buses in order to improve the quality of bus service. Priority treatment includes reserved lanes for buses, preferential access for buses at freeway ramps, and certain traffic engineering improvements.

Traffic free zones were primarily promulgated to control local carbon monoxide problems. The zones are restricted in size, generally about 110 city blocks or less in order to provide pedestrian access to consumer and work areas.

Heavy duty vehicle delivery restrictions during the morning hours were promulgated for the Newark, N. J. area. These were subsequently revoked when further analysis indicated that the restrictions would only shift the peak oxidant value rather than reduce it.

Bike trails have been included in a few Transportation Control Plans to help reduce vehicle miles travelled.

c. Inspection and Maintenance Measures (I/M)

Two different types of inspection programs have been promulgated:

- o an "idle test: program that measures emissions while the vehicle is running in neutral.
- o a "loaded test" program that measures emissions while the vehicle is running in gear on a treadmill-like device called a dynamometer. The effectiveness of these programs depends on the number in the vehicle population that are forced to obtain corrective maintenance and the failure rate limits imposed.

EPA is sponsoring evaluation of two early inspection/maintenance programs. These will provide those States which require I/M under Transportation Control Plans with guidance in selecting and implementing their own I/M plans. EPA will evaluate a "loaded test" program in Arizona and a city "idle test" in Chicago. The evaluation emphasizes early dissemination of data to the States.

d. Mechanical Retrofit

A retrofit measure is the addition of any device, system, modification, or adjustment made on a motor vehicle after its initial manufacture to

achieve a reduction in emissions. The retrofit packages include: vacuum spark advance disconnect with lean idle, air bleed to the intake system, exhaust gas recirculation and oxidation catalyst for both medium- and heavy-duty vehicles.

On March 27, 1974 (39 F.R. § 11334) EPA proposed a centralized retrofit evaluation program. This program will provide those States which have motor vehicle emission retrofit strategies included in their Transportation Control Plans with data which will allow them to decide which specific retrofit device to approve for installation. The concept of this voluntary program is to establish a set of agreed-upon testing procedures. Once procedures are established, retrofit developers will arrange for testing of their devices by independent labs in accordance with the procedures, and EPA will provide the results to the States. EPA's continuing role in the program will be in monitoring the test programs, evaluating, and verifying the test results.

2. Implementation and Cost

It is the intent of the Clean Air Act and the desire of EPA that the plans approved/promulgated to achieve and maintain NAAQS be carried out by State and local jurisdictions. Generally, the States have been slow in submitting initial compliance schedules. This is due to lack of sufficient personnel and understanding of requirements of the plans. Many of these initial problems are being resolved through close coordination between EPA regional offices and the States. Several court suits have been filed by States and other interested parties against EPA in regard to Transportation Control Plans which has also delayed implementation of plans.

Total costs for state imposed transportation controls are indefinite at this time, however, more than 20 million vehicles are affected and an estimated 2 billion may be required for implementation through 1979. About half of this will be to retrofit equipment and half will be accumulated costs of inspection and maintenance (I/M) programs and service station vapor controls. This total will, of course, be larger when additional state implementation plans are analysed to determine their costs.

3. Other TCP Studies

Study of Alternatives of Gas Rationing in the Los Angeles Area

This study was started in the late Spring '74 and the purpose of it is to identify and analyze alternative tax policies for reducing auto vehicle miles travelled (VMT) and concomitant emissions to a level consistent with controls on emissions from non-auto sources and specified ambient oxidant levels. Specific measures to be considered are taxes on auto emissions, gasoline, and parking. The required improvement or increase in public transportation service will be determined and estimates made of the costs and related impact associated with each of the tax strategies. Particular attention will be paid to the effect on fuel consumption. The effect of these taxes on factors having a longer-run influence on vehicle use and emissions will also be considered; auto occupancy, shifts in the size and age distribution of autos, and changes in business and residential location patterns.

The need for this study was strongly re-enforced by the recent submission of State air quality implementation plans. Most of these implementation plans the use of the following strategies: restrictions on auto usage, mandatory inspection of vehicles, traffic controls, increased use of transit, retrofiting

old cars, and parking restrictions. EPA's alternative plans for meeting the standards for some metropolitan areas involved considerable dislocation of transportation activity and were criticized as imposing unacceptable hardships.

It is hoped that this study will expand the range of alternatives presently being considered to deal with problems related to achieving desirable levels of air quality. Such alternative strategies might include tax incentives or disincentives and might use the available information on the behavior of travellers to estimate effects and impacts of different strategies, rather than waiting for the States to acquire actual experience by implementing control plans. To the extent that the use of behavioral data and models is successful in analyzing policy alternatives, much potential but unnecessary dislocations and distruptions, may be avoided.

b. Improving the Integration of Air Quality Considerations in Transportation Planning and Decision-making

In 1974, M.I.T. undertook research to identify means for improving the Transportation Control planning process. This research, which is still underway, has identified a number of actions EPA could undertake to improve this process. EPA and M.I.T. are now discussing possible approaches to implementing the recommendations resulting from M.I.T.'s work thus far.

FOOTNOTES

(1) These deadlines have been changed by the Energy Supply and Environmental Coordination Act of 1974.

(2) The 2.0 gram std. for the 1976 was changed to 1977 through enactment of the Energy Supply and Environmental Coordination Act of 1974.

(3) Statements based on data in "Automobile Exhaust Emissions Surveillance-, A Summary - EPA Report ATTD-1544, March 1973.

(4) These statements are based on data from "Emissions from a Gould Catalyst Vehicle with 25,000 accumulated miles." Report # 75-5, July 1974. Report of the Technoligy Assessment and Evaluation Branch Emission Control Technology Division, Mobile Source Air Pollution Control, Ann Arbor, Michigan.

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(18) An Engine Class is comprised of all cars produced by a single manufacturer, which have the same tupe and about the same size engine.

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